JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

AUGUST, 1860.

CIVIL ENGINEERING.

*On Coal-burning and Feed-water Heating in Locomotive Engines.**

By Mr. D. K. Clark, Assoc. Inst. C. E.

The object of the paper was stated to be, to discuss and compare the existing practice of coal-burning on railways. In burning coal, it was necessary to introduce air, in such quantity as to maintain a sufficiently high temperature in the furnace, and so to distribute it amongst the solid and the gaseous portions of the fuel, as to effect the thorough mixture of the air and the gases. After noticing the insufficiency of the ordinary locomotive boiler in its normal condition for the proper combustion of coal, the author described the methods introduced within the last two years for admitting air above the fuel, amongst the combustible gases. They were classed as—first, acting by currents of air, introduced through tubular or other openings in the sides of the fire-box, uniformly distributed over the surface of the fuel; secondly, by deflection of a body of air, introduced through the doorway, or elsewhere, upon and over the surface of the fuel; and, thirdly, by constructing large and spacious fire-boxes, with large grates and long runs. The third class, which was first in chronological order, was represented by the systems of Mr. M'Connell, Mr. Beattie, and Mr. Cudworth. Of these, the first and second were made with combustion chambers projected into the barrel of the boiler, and the second had, in addition, transverse midfeathers, and brick arches and tiles, for the better mixture of the elements, and the maintenance of the temperature; whilst the third consisted of an elongated fire-

*From Newton's London Journal, June, 1860.

box, with an inclined fire-grate sloping towards the tube-plate. In the application of the first and second classes of smoke-burners, the problem resolved itself into the following conditions:—The immediate and thorough intermixture of a plentiful but regulated supply of air, with the ascending smoke or combustible gases at or near to the surface of the fuel. Practically, it was found necessary for this object to operate from both the front and the back of the fire-box, with air-entrances, arches, and deflectors at the doorway, in various combinations. But such contrivances as dealt with air in bulk, though generally effective in preventing smoke, were stated to be usually attended by the escape of a considerable quantity of unconsumed air, through the flue-tubes, and a difficulty in keeping up steam at high speeds. The various forms of doorway deflectors were also stated to be objectionable, in facilitating, by their mode of action, the suction of particles of coal through the tubes, and the burning of the smoke-box, unless counteracted by an internal arch. The author had found by experience, that to burn smoke when the engine was working, it was sufficient that the air should be admitted at or near the surface of the fuel, by air-tubes distributed over the width of the fire-box, in the front and the back, without the aid of internal arches or deflectors. The draft of air through the front tubes was very strong when the engines ran ahead, carrying the currents into the middle of the fire-box, where they met the counter-currents from the back, effecting the mixture of the air and smoke, and preventing the suction of small coal through the tubes. But, in all systems applied to ordinary fire-boxes operating by means of the draft available in a locomotive engine, aided, when the blast was off, by the steam-jet in the chimney, range of power was wanting to overtake the extremes of intense ignition and rapid generation of smoke-making gases, immediately after the steam was shut off, or when fresh fuel was added; and to suit itself, also, to the quiet state of the fire, when the glow and excitement subsided, as well as to all the varying conditions of a locomotive furnace. The means of extending the range, volume, and power of the air-currents, and of adjusting them to the wants of the furnace, were supplied by the instrumentality of jets of steam, employed by the author as means of inducting and accelerating currents of air. The steam-nozzles, with the air-tubes towards which they were pointed, were like so many miniature blast-pipes and chimneys turned into the fire-box; and they possessed, relatively, the same power of urging and creating draft. By this method of steam induction, the air-currents were delivered with such precision and velocity, as to sweep the whole surface of the fuel, and forcibly to distribute the air amongst the gases.

In practice, it was only occasionally necessary to put the steam-jets in action when the engine was at work if the air-openings were sufficiently numerous, as the action of the blast alone drew a large supply of air through them into the fire-box. The time when the full inducting power of the jets of steam was in demand, was immediately on the steam being shut off from the engine, on drawing up to a station,

or otherwise. Then, the heat in the fire-box was fierce, and there was an extensive distillation of combustible gases, which were discharged as smoke from the chimney, unless met and consumed by the inducted currents above the fuel. The intenseness of the heat subsided rapidly, and the jets could be moderated as desired, and continued in action until the engine was again in motion. The indraft of air into the fire-box could be regulated by the use of slides or dampers over the air-openings. But, by so limiting the number of air-openings, and consequently the supply of air, as to prevent any material excess of supply when the fire was in ordinary condition, the dampers might be dispensed with in practice, without prejudice to the economy of fuel.

In making a general comparison between the various methods of coal burning without smoke, there was the difficulty of the diversity of circumstances as to time, fuel, engine, and duty to contend with. The performances of several engines burning coal, on different systems, and the same or similar engines using coke, had, however, been tabulated. It thus appeared that, of the three systems of extended fire-boxes, by Mr. M'Connell, Mr. Beattie, and Mr. Cudworth, with nearly equal gross weights of engine, tender, and train—100 to 116 tons—and at about the same speed, the consumption of coal was as follows :—

		Per ton gross.
Mr. M'Connell's,	35½ lbs. Hawkesbury coal per mile,	or ·31 lb.
Mr. Beattie's (with cold water),	24 lbs. Griff & Stavely " "	or ·235 lb.
Mr. Cudworth's,	26 lbs. coking coal, "	or ·225 lb.

Of the systems of coal-burning grafted on the common fire-box, with passenger trains, comparative results were given of Mr. Douglas' with a doorway deflector on the Birkenhead Railway; Mr. Yarrow's with a brick arch and air-bars on the Scottish North-Eastern Railway; Mr. Connor's with a brick arch and door deflector on the Caledonian Railway; Mr. Frodsham's with a doorway deflector and steam roses in the fire-box, used by Mr. Sinclair on the Eastern Counties Railway; and the author's with air-tubes and steam-inducted currents, used by Mr. Cowan on the Great North of Scotland Railway. It appeared that, with eight to ten carriages, the following were the performances :—

	Gross Weight. Tons.	Gross Coal per mile. lbs.	Per ton gross. lb.	
Mr. Douglas, .	90	28·4	or ·32	Welsh.
Mr. Yarrow, .	86	25·7	or ·32	Fifeshire.
Mr. Connor, .	88	22·2	or ·26	Lanarkshire.
Mr. Frodsham,	93	23·3	or ·25	Stavely.
Mr. Clark, .	110	21·0	or ·19	Fifeshire.

Showing that, with the author's system, less coal was used with a heavier train than with any of the others. Similarly favorable comparisons were made in the working of goods engines.

The Great North of Scotland Railway, on which the author's sys-

tem was in full operation, was stated to contain long gradients, several of which varied from 1 in 100 to 1 in 150, with frequent curves; and the goods engines could take up these inclines 35 fully loaded wagons, 460 tons gross train weight, at 10 miles per hour.

In conclusion, it was stated that the author's system of smokeless coal-burning was distinguished from others by its simplicity, durability, efficiency, and simple management. There was no construction of any kind within the fire-box, and, consequently, no wear and tear by exposure to intense heat. At the same time that it commanded the entire range of the fire-box, it did not interfere with or impose extra labor in the management of the fire. The manipulation was simple; the air-tubes being placed at a sufficiently high level to command the surface of the fire at all times. The whole business of smoke-prevention was comprised in the occasional operation of the induction-jets, by means of a tap under the hand of the engine-driver, and the occasional aid of the chimney-blower, to carry off the products of combustion. By the proper use of this system, the fire might be "damped," or kept dull, when desired, where an engine had to wait at a station, without raising the pressure of the steam; as the forcible indraft above the fire might be made to prevent a draft through the fire, and consequently to check or to suspend the combustion of the fuel; conducing both to safety and to economy, and favorably contrasting with other systems, in all of which a powerful blower in the chimney was needed, when standing, incurring dangerous pressures and waste of steam.

In feed-water heaters, it was stated that little had as yet been done, except by Mr. Beattie, whose apparatus, though efficient as a heater, was found, it was believed, to be too complicated for general use, and difficult to keep in order. The author had recently introduced a simple and compact heater, in which the steam from the blast-pipe was projected into a short tube, in conjunction with the feed-water, which was delivered in a thin annular sheet around the steam-nozzle. In this short tube or chamber, the water was broken into spray by the steam; the steam was instantly condensed, and the water was raised to a high temperature, at or near the boiling point. It had given satisfactory results in a 20 H. P. stationary engine, and would shortly be applied to a locomotive engine. It was said to be well adapted for agricultural and other engines on wheels, where lightness and compactness were considerations of importance.

In the course of the discussion upon Mr. D. K. CLARK'S paper, "*On coal-burning and feed-water heating in locomotive engines*," it was remarked, that the plan of coal-burning advocated by the author seemed to be similar to that adopted by Mr. Jenkins, and which had been some time in use on the Lancashire and Yorkshire Railway, except that in the former jets of steam were employed to accelerate the currents of air. Mr. Jenkins' system consisted simply in making a certain number of the stays hollow instead of solid, through which the air was allowed to pass, and, mixing with the products of combustion, effected the prevention of smoke. Movable slides were fixed

on the outside, so that the apertures could be opened or closed at pleasure; and thus, either coal or coke could be burned in the same engine. The system could be applied to old engines, at an expense of a few pounds per engine, and was said to be simple and effective.

It was stated that the use of tubes through the sides, and in some cases the front, of the fire-box, for preventing smoke, had been tried nineteen years ago by Mr. Samuel Hall, the pioneer of surface-condensation, on the Midland Railway, and the same system was now practised on the Great Western Railway. The smoke, though then not entirely consumed, was believed to have been as effectually got rid of as at the present day. Formerly the defect was, that the tubes were burned; but where coal could be obtained at much less cost than coke, a want of simplicity, or the necessity of slight additional repairs, might be overlooked. When first brought forward, an objection was taken to Mr. Hall's plan, that when an engine was standing at a station, black smoke was emitted. This was remedied by the introduction of a small jet of steam in the chimney, for creating a draft when the engine was at rest; but the noise thus produced caused the plan to be laid aside.

In regard to the general question of smoke-prevention, it was argued that neither deflecting plates nor brick arches were needed; but only the introduction of a sufficient quantity of air, moderately diffused over the fuel. In 1856, the use of hollow stays and small jets of steam had been suggested by Mr. Robert Longridge, particularly for marine engine boilers, where there was a difficulty in getting the proper quantity of air through the tubes; but it was thought that, in a locomotive, the requisite quantity of air to consume the hydro-carbons might be introduced by the hollow stays, without resorting to steam jets.

As to the comparative heating powers of coal and coke, it was sometimes asserted that the same evaporative effect would be obtained from the coke made from a ton of coal, as from the original ton of coal itself. This view was dissented from, and it was stated that careful experiments with Garesfield coal and coke showed the evaporative power to be as 100 to 89, respectively, weight for weight. In other words, 1 lb. of coal evaporated 12·54 lbs. of water, whilst 1 lb. of coke evaporated only 11·16 lbs. of water. But, inasmuch as 100 tons of coal produced only 66 tons of coke, it was evident that while 1 lb. of coal would evaporate 12·54 lbs. of water, the same weight of coal, converted into coke, would only evaporate $11{\cdot}16 \times {\cdot}66 = 7{\cdot}44$ lbs. of water; so that the true proportion was as 100 to 58.

On the other hand, it was stated that, with Midland coal, 20 cwt. of coal produced 11½ cwt. of coke, besides other products, and 6 cwt. of coke evaporated exactly the same quantity of water as 7 cwt. of coal: consequently there was a loss in converting coal into coke, for the purpose of producing steam; but considered only in reference to weight, coke had an advantage over coal in the proportion of seven to six.

It was contended that, in order to enable a proper comparison to

be made between the amount of fuel used per mile and the gross load carried, the paper should have showed—1st. What was the greatest altitude surmounted in each case, the total length of the line, the ruling gradient and its length. 2d. What was the average speed per mile for the whole distance run. And, 3d. How many lbs. of water were evaporated by 1 lb. of coal.

It was observed that, in attempting the general introduction of anthracite coal in locomotive engines in the United States for long and heavy traffic, it was found that, although there was no smoke, it was difficult to keep up the steam, and the fire-box and fire-bars were quickly burnt out. Notwithstanding these objections to its use, anthracite was in some cases a cheaper fuel than wood. Anthracite coal was burned on the Reading Railroad at the rate of 120 lbs. per mile, in engines weighing 28 tons, and carrying a gross load of 750 tons, at from ten to twelve miles an hour, on a level. The evaporation of water was from 5½ lbs. to 6 lbs. only per pound of coal. A brief description was given of Phleger's, Dimpfel's, and Boardman's boilers, which had been made to burn bituminous as well as anthracite coal, and were used on passenger as well as goods trains. Each furnished considerable space for combustion, and air was admitted in numerous fine streams over the fire. They were all, however, heavy and complicated, and inapplicable to existing stock. Within the last three or four years, renewed attempts had been made to adapt the existing stock of engines to the use of bituminous coal. The difficulties consisted in the large quantity of coal required to be burned in a given time, under an intense draft, and in the clinkery character of the coal itself. The engines were not heavier, on the average, than in England, nor had they more heating surface; but they burned more fuel and evaporated one-fourth more water in a given time. In December, 1856, Mr. G. S. Griggs, of the Boston and Providence Railroad, introduced a fire-brick arch, below the tubes, in the fire-boxes of some of the engines of that line. With a few holes for the admission of air above the fire, this arch was found to improve the working of the fire-box, when burning coal. On the Iowa Central Railroad, the grates of the coal-burning engines were at one time covered with fire-brick, so as to leave only about two square feet of the original surface of the bars exposed; and of this area, less than one square foot was air-opening. More recently, perforated door-plates and air-distributors (the latter set up within the fire-box) had been extensively adopted.

It was stated, in reply to the observations which had been made, that in a comparative trial of the author's system and Mr. Jenkins', on a metropolitan railway, on the same passenger engine, and on the same duty, the former consumed 4 lbs. per mile, or 12 per cent., less coal than the latter; that the saving of coal by smoke-prevention in locomotives had been found to be at least 18 per cent.; that the information demanded, for the purpose of making a proper comparison, was given in the paper; that it was of no use to state altitudes simply, unless particulars of inclines and length of trip were also given.—*Proc. Inst. Civ. Eng., May* 1–8, 1860.

*On Combined Steam.** By the Hon. JOHN WETHERED, U. S.

It was stated that at the present day the great desideratum in marine engines appeared to be, to obtain increased power or economy in the consumption of fuel, without the commercial disadvantage of occupying more space by the enlargement of the boilers and machinery. This object it was believed had been attained by the application of ordinary and superheated steam mixed. The mode adopted in carrying out this system was, to attach another steam pipe to the boiler, for conveying the steam to be superheated to pipes or other contrivances placed in any convenient form near the fire, or in the uptake or chimney of the boiler, or in a separate furnace; the superheated steam being added to the ordinary steam at or before its entrance into the cylinder. In its passage through the superheating apparatus, that portion of the steam was raised by the waste heat to a temperature of 500° or 600° F. The heat thus arrested was conveyed to and utilized in the cylinder, by its action on the other portion of steam from the boiler, which was more or less saturated according to circumstances. The combined steam was used in the cylinder at from 300° to 450° F., instead of at the low temperature at which steam was generally employed. The effect of using the two kinds of steam was, that the superheated steam yielded a portion of its excess of temperature to the ordinary steam, converting the vesicular water which it always contained into steam, and expanding it several hundred-fold; whilst at the same time, the ordinary steam yielded a portion of its excess of moisture, converting the steam gas into a highly rarefied elastic vapor—in other words, into pure steam at a high temperature.

It was asserted, that repeated endeavors had been made in England, France, and America, to employ steam simply dried, or superheated, and as often abandoned. This plan certainly resulted in partial economy; but owing to the high degree of temperature necessary in this case, the lubricating materials were dried up, and then the packing and rubbing parts of the machinery were destroyed. Moreover, when all the steam was superheated the temperature of the steam in the cylinder was beyond the control of the engineer. It was this difficulty which had led to the discovery of the system of employing mixed steam, which was entirely under control; for by merely turning a valve it could be so regulated as to produce the highest mechanical effect, with the most perfect lubrication to the slides and cylinders. Another advantage was, that if any accident should happen to the superheating apparatus, the cylinders could still be supplied with plain steam alone.

A series of trials on board the R. M. S. S. *Avon* had shown that the pressure in the boiler being in all cases the same, with plain steam the result was 1070 I. H. P.; with the steam from three boilers superheated and from the fourth plain it was 1076 I. H. P.; while with the steam mixed in the proportions of 61 superheated and 69 plain, 1200 I. H. P. was produced. The Lords of the Admiralty were stated to be so well satisfied with the results of experiments continued over twenty voy-

* From the London Civ. Eng. and Arch. Jour., May, 1860.

ages, that they had determined to extend the application of the system in the Royal Navy, and H. M. S. S. *Rhadamanthus* had been ordered to be fitted with it. Mr. A. C. Hobbs (Assoc. Inst. C. E.) had applied it to a high pressure boiler and engine, and Mr. Dorman had adapted it to an engine which did not produce the required power. The combined steam was also used in all the steamers of the Collins line. Experiments on board the *Gibraltar* showed that superheated steam at a pressure on the boiler of 10 lbs. produced 222 I. H. P.; ordinary steam at 14 lbs. pressure, 307 I. H. P.; while combined steam at 15 lbs. pressure gave 376 I. H. P.

When steam was merely superheated or dried, it was converted into steam gas. It consequently partook of the nature of gas; was a bad conductor of heat, and gave out with difficulty the heat necessary to transform it into mechanical power. On the other hand, mixed steam participated in the qualities of steam proper and of superheated steam, and being a pure highly rarefied vapor, which readily parted with its heat, thus produced greater mechanical effect.

By the application of combined steam the following advantages, among others, were said to be obtained:—1. An economy of fuel of from 30 to 50 per cent. 2. A diminution of one-third in the feed-water. 3. The employment of smaller boilers to produce the same power. 4. Facility of maintaining any desired pressure, or of increasing it at will in cases of emergency. 5. A steamer would make a voyage one-third further with the same weight of coals; or one-third the space now occupied by the fuel might be used for freight. 6. Less risk of explosion. 7. Boilers would last one-third longer. 8. A better vacuum was obtained. And, 9. One-third less injection water was required.

April 3.—The entire evening was occupied by the discussion of the preceding paper "*On Combined Steam.*"

In commencing the discussion it was remarked that the indicator cards taken from H. M. S. S. *Dee*, when using simple superheated steam and when working with combined steam, the pressure being the same in both cases and the supply valves equal in area, showed that a better vacuum was obtained and that the expansive force was much greater when using combined steam. It had been ascertained that the consumption of fuel was 2·57 lbs. per I. H. P. per hour with combined steam, whilst it averaged 5·53 lbs. per I. H. P. per hour with plain steam. The result of twenty experimental voyages in that vessel gave, on the combined system 500 H. P., by superheating simply 409 H. P., and with plain steam 404 H. P.

A case was also mentioned in which combined steam had been applied to a non-expansive engine, where a reduction was effected in the consumption of fuel of from 36 cwt. to 24 cwt. per week; while about one-third less water was consumed.

It was admitted that great praise was due to the author for having recalled public attention to the advantages derivable from superheating steam. But it was doubted whether the combined system possessed any peculiar merit over simple superheated steam. If the mix-

ture were made just at the entrance to the cylinder, it was difficult to understand what difference there could be between that plan and at once heating the whole of the steam to a uniform temperature. It was questionable whether in a good expansive engine the application of a most efficient system of superheating, that completely prevented condensation, would result in a saving of more than 15 per cent. It was stated that in the early experiments in H. M. S. S. *Dee*, when superheating was tried, the steam was throttled, owing to the small size of the pipes; and that the apparent superiority of the combined system was due to the large ordinary steam pipe being in connexion with the engines in addition to the superheating pipe, and not from the fact of the steam being mixed. When a different arrangement was made, the superheating gave results quite equal to the combined system.

It was believed that with the best boilers there would be a saving of 15 per cent. by the use of superheated steam; and in one vessel, where there was an indifferent construction of boiler, there was an economy of 34 per cent. due partly to improvements in the boiler, and partly to the application of the apparatus giving more steam room. In one of the vessels belonging to the Intercolonial Royal Mail Company, to which superheating apparatus had been added, the consumption of fuel was reduced from 2986 lbs. to 1900 lbs. per hour on an average of four or five days' steaming between London and Milford Haven. Similarly, in one of the boats belonging to the General Steam Navigation Company, traveling between the Thames and Scotland, an average of twelve voyages previous to superheating showed a consumption of 126 tons of fuel per voyage. This was now reduced to 90 tons per voyage. The temperature in the uptake was formerly about 650°; now it had not been reduced more than 50°, but the temperature of the steam had been increased 100°.

It was remarked that the gain in using superheated steam did not arise from any physical law, but from the prevention of a loss by the use of dense steam. When the steam entered the cylinder, if there was but one degree of heat less in the cylinder, water must be formed. When the vacuum stroke was made, the deposited water, being relieved of the pressure due to its temperature, was rapidly vaporized and passed off as rarefied vapor, cooling the cylinder. On the steam entering to make the return stroke it brought the cylinder up to a temperature due to the pressure, and the stroke was made at that loss by the deposit of water over the whole interior surface of the cylinder and its adjuncts. When the condenser again came into action the same thing recurred, and so on continuously. A pressure indicator applied simultaneously with thermometers, showed that the loss of temperature without working expansively was 20°, with an average pressure of 6 lbs., indicating a loss of steam of between one-third and one-fourth. This injurious effect must always occur when using dense steam; whereas, in employing superheated steam there was no deposit of water, and the result was analogous to that of a permanent gas, but with the advantage of easy and complete condensation. Further, when the vacuum stroke was performed, since the cylinder was per-

fectly dry, the exhaustion of the whole steam was effected instantaneously. With dense steam, the cylinder being wet, the deposited water had to be vaporized and condensed, thus damaging the vacuum. As this action did not occur with superheated steam, some increase of useful effect was produced on that ground. The condensing appliances were also relieved by so much as was gained in the cylinder.

It was believed that the practical limit of the use of superheated steam would be in giving it such an additional amount of caloric as would permit of its remaining dry steam to the end of its required expansion. When steam was expanded a large quantity of heat became latent. In consequence, the full effect was not obtained from expanding ordinary steam, because as it expanded in the cylinder it cooled, and there was not sufficient caloric to keep up the specific heat during the stroke.

It was observed, that the experiments on H. M. S. S. *Dee* showed a saving of 23·8 per cent. in favor of superheated over plain steam. With regard to temperature, the superheated steam lost 20° on its passage to the cylinder, 82° after entering the jacket, and 26° more after entering the cylinder; while the plain steam lost 23° only, after making its entire circuit from the boiler to the cylinder. In another experiment there was an economy of fuel of 20 per cent.; the minimum consumption at full power being 2·6 lbs. of Welsh coal per H. P. per hour. It was thought that Mr. Wethered's system was about as economical as the superheated, when the whole of the steam was passed through the superheating apparatus. It was contended, that superheating should not be carried farther than to prevent condensation in the jacket, and therefore in the cylinder; and it was thought that the whole of the steam passing into the cylinder should go through the jacket, rather than that the jacket should be fed by small pipes.

It was pointed out that mixing ordinary saturated steam with superheated steam, gave a ready means of regulating the temperature. It was thought, that the increase of temperature should never exceed 100°. If a compensation-rod were introduced into the steam-pipe, so as to limit the admission of steam in proportion to the temperature, beneficial results might be obtained.

In reply to the observations which had been made, it was stated, that it had not been desired to advance any crude theory, but rather to narrate facts. The rationale of the principle advocated had however been given in the paper, nearly in the words of Prof. Regnault, of the French Academy. The difference between superheated and combined steam was stated to consist in this, that superheated steam being of a gaseous nature, was a bad conductor of heat, and parted with it with difficulty; whereas combined steam being pure vapor, and a better conductor of heat, parted with the heat more readily and left more heat in the cylinder of the engine, which was converted into mechanical power. The engineer-in-chief of the United States Navy had proved that there was an economy in the use of the combined steam of 52·5 per cent. over ordinary steam, and 25 per cent. over superheated steam. The experiments conducted under the authority

of the Minister of Marine of France, gave nearly the same results, the figures being 52·7 and 24·0 per cent. respectively.

In the British Admiralty yacht *Black Eagle*, there had been found to be a saving of 20 per cent. in favor of the combined over the simply superheated steam.

In closing the discussion it was stated that the general opinion appeared to be, that the practical introduction of the system of superheating steam was greatly owing to the exertions of Mr. Wethered. He had succeeded in moving the British Board of Admiralty when, perhaps, an English engineer might not have been so successful; but this should be a subject of congratulation, as it was desirable at all times to give the greatest encouragement to foreigners, so as always to attract the best talent from other countries. The case did not, however, seem to be clearly established in favor of combined steam; it rested upon the facts which had been stated, and not upon any scientific explanation of the rationale of the principle, such as would account for the results claimed for it. When more than ordinary attention was given to any machine in daily use, that of itself would often lead to economy. This attention was invariably given when any new invention was being tried, and the whole improvement, or economy, was supposed to arise from the particular modification then being tested.—*Proc. Inst. Civ. Eng., March 27th and April 3d*, 1860.

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*Extract from a paper "On Indian Railways; with a description of the Great Indian Peninsula Railway."** By Mr. JAS. J. BERKLEY, M. Inst. C. E.

The materials procurable in India for railway purposes were then succinctly noticed. In reference to the manufacture of Indian iron and the supply of coal, it was remarked that active and successful operations depended more upon the completion of railway communications, than the railways did upon a local supply of those materials. The properties of a few of the various kinds of woods which had been extensively used, were then stated. Those which had been successively converted into sleepers were—teak, blackwood, khair, errool, and red eyne. The cost of a sleeper varied from four shillings to seven shillings and seven pence, the average price being about six shillings. Tolerably good bricks had been occasionally procured and used in arches, but in such cases a proportion of only twenty per cent. had been selected from the best native kilns. The price ranged from ten shillings to twenty-four shillings a thousand. Gunpowder cost, when made upon the spot, about £34 per ton.

Native labor, by which these works had been executed, was cheap, but very inferior to that of England. Nearly one hundred thousand men had been employed upon the Great Indian Peninsula Railway lines at one time, and as many as twenty thousand on the Bhore Ghaut Incline alone. The wages of the several classes per day were now—

*From Newton's London Journal, June, 1860.

native maistries, or foremen of masonry, brickwork, or carpentry, 2*s.* 6*d.*; masons, 1*s.* 9*d.*; bricklayers, 1*s.* 3*d.*; carpenters, 1*s.* 6*d.*; smiths, 2*s.*; miners (a very large class), 9*d.*; excavators, 7½*d.*; and laborers, 6*d.*

The whole of the Great Indian Peninsula Railway had been executed by contract, and this, it was believed, had led to remarkable economy in the construction of the various lines. The average cost of the opened portions had been about £ 8000 per mile. The introduction of the contract system into India, on a large scale, was an important effect of railway enterprise, and it was thought that its advantage could not be long confined to railway construction.

Railway enterprise had already produced important effects in Western India. It had earned, at a remarkably low tariff, more than the guaranteed dividend. The working expenses had been low, notwithstanding the dearness of imported fuel and European superintendence. It had afforded the advantages of the best mode of conveyance to immense numbers of the poorest and lowest orders of the people. It had generated for itself new sources of traffic. It had achieved its success in competition with water carriage, and when it was only in a fragmental state. Although constructed in what was erroneously called an expensive style, the traffic had already demanded the partial laying of a second line of rails. It had raised the wages and increased the effectiveness of native labor, and profitably employed thousands of the carriers of the country. It had opened quarries and brickfields, had impelled trade into unwonted activity, and drawn largely upon the resources of the country. It had lessened the expenditure of the state, by its cheap conveyance of mails and troops, and had augmented its income, by large payments of tolls and duties. *Proc. Inst. Civ. Eng., May* 8, 1860.

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*The North Atlantic Telegraph.**

Long before the Atlantic Telegraph, which has repeatedly failed, was commenced, Col. T. P. Shäffner, an American gentleman of some repute as an electrician, called upon us, we recollect, for the purpose of pursuing certain interesting inquiries into the progress of the electric telegraph in this and other countries. From time to time we have been advised of the efforts subsequently made by this gentleman in the interests of an Anglo-American line of telegraphs, and now we have before us a full statement of the plans to which his prolonged inquiries and investigations have conducted him.

Col. Shäffner proposes to establish a North Atlantic telegraph on the following route, viz: From the North of Scotland to the Bay of Thorshaven, Stromöe Isle, of the Faröe Isles. The length of the cable for this section will be about 250 miles. The next section will run from Westermanshaven, of the same isle, to about Portland, South Iceland, a distance of about 350 miles. From this landing the line

* From the Mechanics' Magazine, May, 1860.

will be constructed across Iceland to Reijkiavik. From the Bay of Reijkiavik the next section of cable will be run to some bay on the east coast of Greenland, south of latitude 61 deg. north. This distance will be about 550 or 600 miles. It is proposed to run the line across the southern end of Greenland. The fourth section of cable will be run from one of the bays of the west coast, south of the latitude 61 deg. north, to Hamilton's Inlet, on the Labrador coast, a distance of about 600 miles. The aggregate submarine telegraph will be about 1750 miles; land lines about 300 miles, total, some 2050—about the same length as the Atlantic cable from Ireland to Newfoundland. In a paper read a few days since before the Royal Geographical Society, Col. Shäffner quoted the above figures as correct estimates, and stated that the concession for this telegraph has been granted by his Majesty the King of Denmark, so far as it may occupy Danish territory. There is no monopoly of the line reserved to the Danish government, but its impartial use is guaranteed to the whole world. The government has pledged itself to "bestow all necessary care, vigilance, and means which may be within its command, to insure the free, impartial, and unhindered use of the said telegraph line." If, however, the British government should desire a wire for the transmission of its own despatches, a franchise can be given to it, and the use of that franchise will be defended by the Danish government "with all the means within its command."

The distinguishing feature of this plan is, of course, the shortness of submarine circuits which it secures, and the consequent avoidance of those electrical difficulties which attend the use of very long circuits. The longest circuit required will be but 600 miles—which is 150 miles less than one already in successful operation. Through such a circuit the promoters say they can transmit at least twenty words per minute. "It will be a financial question that will determine the capacity of the cables for the commercial telegraphy," says Col. Shäffner. "Between Scotland and the Faröes, and between the Faröes and Iceland, cables can be laid that can equal the working of a double line of cables across the other sections of the route, or perhaps it may be found best to construct them for the short sections with two wires for telegraphing, and on the other sections with three or more conducting wires. If either one of the sections fail, the whole are not lost, and another cable can be promptly submerged."

The depths of the seas which would be traversed by the proposed cable are but little known. A few soundings were taken on the route last autumn, when Col. Shäffner made the voyage from Labrador to Greenland in a 200-ton barque, and effected a reconnaissance of that part of the route. His examinations were general, and not in sufficient detail to justify him, in his opinion, in specifying the proper localities for the landings of the cables; and it is for this purpose, and for making the most complete survey of the seas and lands, and for making scientific observations generally, that a government expedition has been requested, as stated in our last number. Besides the aid to be given by the government in the survey, we understand that a pri-

vate expedition will be sent to fix the route on the respective territories to be traversed by the telegraph. The water between Scotland and the Faröe Islands, and thence to Iceland, is not very deep—not exceeding, perhaps, 1000 fathoms, and there can be no doubt but that the bottom is very deep mud. The soundings taken last fall between Iceland and Greenland, proved the greatest depth of water was 1540 fathoms. The mud brought from the bottom has been examined by Professor Ehrenberg, of Berlin, and he says that he found it "to contain numerous shells with life-being forms therein, which (in his opinion) exist alive at the bottom of the sea." With regard to the sand contained in the specimens, he says, that "it is no rolling sand, but fragmentary, broken, and dissolved stones of mountains. The granules are not round, but with acute sides. The granite sand consists of much glimmer and quartz, with green crystal fragments, which might be hornblende were there particles of pumice-stone, but which are not at all therein to be found." It would seem that the bottom of the sea gradually descends to 1540 fathoms from Iceland, and then in the same manner ascends to the Greenland coast. To determine the correctness of this opinion further soundings are required. The Arctic current, perhaps some thirty feet deep, and by some supposed to be fifty miles wide, carries with it large quantities of ice, from which earth drops to the bottom of the sea. The sea between Greenland and Labrador was found by Col. Shäffner to be 2090 fathoms, which was about under the Arctic current, west of Greenland, latitude 61 deg. ·05 min. North-west of this sounding the deepest water found was 1840 fathoms. The bottom in Davis's Strait was soft mud, except under the Arctic current, where it was coarse sand, which had been evidently dropped from the ice. On many icebergs may be seen large quantities of sand and boulders of several inches in diameter.

The precise places for the landings of the cables have not yet been determined upon, but Col. Shäffner has brought together many useful facts for the guidance of the projectors. There are good bays on North Scotland, and there need not be any fears as to that part of the route. The bay of Thorshaven, island of Stromöe, of the Faröe group, is approached from the deep sea without obstruction, and its bottom is sand. The average depth of water in the bay is about 20 fathoms. Thorshaven is the capital of the Faröe islands, and has about 900 inhabitants. The cable to Iceland will leave Westermanshaven on the west coast of the Stromöe Isle. The bay is deep, he says, bottom sand, and free from the ocean waves. On the south coast of Iceland, about long. 19 deg. W., or at Portland, it is proposed to land the cable. The bottom of the sea approaching nearly the whole south coast of Iceland is sand. The coast is free from ice winter and summer. The cable to Greenland will run, Col. Shäffner continues, from Reijkiavik bay. The depth of water in this bay is favorable, the bottom is mud and sand. It is free from ice, winter and summer, excepting a little crust near the shore. Arctic ice is never seen in that bay, except, perhaps, once in a century. Reijkiavik is the capital of Iceland, and its inhabitants have the highest

degree of education. The landing-places on Greenland require to be selected with great care, and after much investigation. It is proposed to land on the east coast, in one of the many bays south of latitude 61 deg. north, and on the west coast near the town of Julianshaab, or south of that place, connecting the two with a line across Greenland. The bays penetrate to the interior ten, twenty, or thirty miles, and some of them never freeze, nor does the ice from the sea go up them more than a few miles. They are very deep, and bergs never ground in them; the bottoms are of mud and sand. The characters of the bays on the two coasts are much the same, and the Arctic current does not approach the coast on either side. From the sea into these bays the water is deep, far below the reach of the greatest icebergs. To make the selection of the proper bays for the landings of the cables, the fullest information as to the depth of water from the sea will be required. Some of the inlets bring out ice, but most of them do not; many of them are ten miles wide. As to Labrador, Hamilton's Inlet affords all the desired advantages. This inlet runs interior about 140 miles, and at its mouth it is thirty miles wide. The water is deep and the bottom is sand. At its mouth there is a deep trench to the sea, and a cable laid in that trench would never be disturbed by the sea. Above and below the mouth of Hamilton's Inlet there are shoals or reefs, some thirty miles from the coast, and many icebergs ground on them. After they melt or break to pieces they pass over and beyond the mouth of the inlet. They never ground at the mouth, nor do they enter into the inlet.

The above statements are made, let it be understood, on Col. Shäffner's authority. We take the following extract also from his Paper:—

The landings on the Faröe Islands and Iceland will never be disturbed by ice. They are open ports, and vessels can go and come from them at all seasons of the year. The coasts of Greenland and Labrador are beset with much ice. The east coast of Greenland is but little settled. The inhabitants trade with the colony near Cape Farewell, but they go and return from time to time in their skin-boats. The Arctic or Spitzbergen current, with the floe ice, does not approach the coast, and much of the time that the floe ice runs between Greenland and Iceland the water near the coast is free from ice. The floe ice on the east coast may be seen in more or less quantities in the months of February, March, April, May, and a part of June. Sometimes it appears in the last days of January, and occasionally disappears in May. The coast or berg ice may be seen occasionally throughout the year. On the east coast neither the berg nor the floe ice penetrates the bays, and a cable laid therein would never be disturbed by them even were the waters shallow. The hills on the coast are covered with grass and berry bushes. The climate is not severe. The native ice is not very thick, and if it was the cable could not be injured by it. The west coast in Julianshaab district is settled by some 3000 Esquimaux and Danes. Their houses are to be found on many of the hills, and the skin-boats are to be seen at nearly all times in some of the bays. The floe ice runs northward a few miles from the coast during the months that it is seen on the east coast. Between the green hills and the floe the sea is open and free from ice—except, perhaps, here and there a berg may be seen. Icebergs from Baffin's Bay, or the various "blinks" more northward, will be found scattered along the coast. Some ground on the reefs or shoals, some are blown into the bays, and others pass off to the south. Those blown into many of the bays seldom, if ever, get out. If the bays have currents from the interior they are taken out to sea, but if their waters be quiet, as many of them are, the bergs are blown to the land and ground. There they remain until the winds, the sun, and the tidal waves crumble them to pieces. Between the Arctic current and the coast many of the icebergs remain for weeks, and, in fact, until broken to pieces and

melted. The largest iceberg may be some eighty feet above water, but as to their depth in the water, no one knows, nor is it possible to ascertain. The theory as to the specific gravity of ice cannot be applied to determine the depth of any given berg. The ice above water may be the cone ascending from a very broad base. In most cases very high bergs are very wide below water, and when the base becomes reduced, the berg falls, and a new projection is seen from the water. The crumbling of bergs, and the changing of their positions, are to be seen going on at nearly all times. A rough sea soon exposes the form and size of the berg, and a careful judgment can determine the probable bulk. The bergs on the Labrador coast are of the same kind as those on the Greenland coast. They go south in great quantities until checked by the eddy currents on the east coast of Newfoundland. Many of them enter the bays of Newfoundland, and a cable laid therein will be more liable to be injured by the ice than those laid on the Greenland or Labrador coasts.

We think Col. Shäffner is likely to meet with all needful encouragement in this attempt of his. The commercial world wants a telegraph to America, and, notwithstanding former failures, are prepared to find funds for a new attempt, if it has any real promise in it. Regions of thick-ribbed ice do not seem very promising places for telegraphs and telegraphic operations; but late events have familiarized us with those regions, and there is good reason for believing that the mechanical difficulties which will interfere with the new Atlantic Telegraph will be more easily surmountable than the electrical difficulties of the more southern route. In the absence of a mid-Atlantic island or two, it may be wise to run away northward for a bit of land to plant a station upon.

Meantime we must not forget that the old Atlantic Telegraph Company have sent out an expedition for the purpose of restoring their cable, which has only failed, they say, because a fault in the insulation, which existed before its immersion, was allowed to escape notice. They contend that there is reason to believe the insulation remains perfect in the deep-water portion, and that experience affords grounds for anticipating the recovery of the injured portions. Mr. Saward, the Secretary to the Atlantic Company, in a letter just received, compares the two rival routes, showing that the extreme length of the existing Atlantic line of Telegraph (from London) is but 2650 miles, whilst that of the Danish route will, he says, be 3773 miles. To work this line of nearly 4000 miles at a remunerative speed would, he adds, require relays at each broken point—in all not less than 14 sets of relays to be worked in synchronous connexion, each with each. These continuous sections, owing in a great degree to their circuitous course and their constant change of position in reference to the magnetism of the earth—the first links being south to north, then east to west, and lastly, north to south—would, he argues, more than in any other quarter of the earth, and in a greater ratio than any direct line, be subject to the adverse influences of earth currents, magnetic storms, aurora borealis, the chance of accidents, and other disturbing causes, always more incident to long and frequently-broken circuits, and any one of which would destroy for days the synchronous working of the relay system, and reduce the operation at best to one of slow and tedious repetition from station to station. "I would further remark," he says—and he is quite right in saying so—"that any survey of

the Greenland coast, with the view to ascertain its capabilities as a cable station, would not be at all conclusive or satisfactory if it does not embrace, at the very least, eight or nine months' resident examination of the coast, both on its eastern and western sides; as the practicability of that route for telegraphic purposes must depend, not merely upon the bare possibility of laying a cable there during one particular month in a Greenland summer, but upon the probability of its remaining intact during the stormy seasons, and the facilities for rapidly repairing it when broken."

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*On the Wave-line Theory.** By JOHN SCOTT RUSSELL, Esq., F. R. S. Being an abstract from his Paper read before the Institution of Naval Architects, March 3, 1860.

After briefly recapitulating the chief portions of the Paper which he read at the Inaugural Meeting, two days before, the Author said his object in his present Paper was to consider the nature of the motion imparted to water when disturbed by a vessel pushed through it by motive power of any kind. It was in the investigation of this subject that he had seen some of the most important principles that guide us as to the general proportions of ships, as well as their shape, with reference especially to velocity.

The first inquiries to be made were,—what became of all the water which a ship removed out of her way? and how did it get out of the way? In prosecuting these inquiries the Author had first employed a small trough or canal, a foot wide, a foot deep, and of considerable length, and began with a very simple experiment. He supported a small heap of water above the level of that in the trough by means of a partition at one end, and then withdrew the partition to see what the water would do, and found that it assumed a beautiful wave-form of its own, ran along the whole length of the channel to the end, and left the surface of the water over which it passed as still as it was before. Had the end of the trough been just level with the surface of the still water, the wave would have jumped over and left the whole of the water in the canal perfectly undisturbed. This phenomenon is now known as the "solitary wave of translation." This wave would travel to an almost incredible distance. The Author had followed such a wave on horseback, and by other means, for miles. It leaves a little of itself, however, along the whole surface over which it passes.

The next fact ascertained was that, whenever the bow of a ship is moved through the water a wave of this kind is produced, and this is the "traveling" or "carrier wave," which gets rid of all the water out of the canal which the vessel has to excavate. The ship feels no more of it, for it spreads itself in a thin film all along the surface of the water ahead of the vessel—not behind the vessel, nor on each side of it—with a far greater velocity than that of the vessel itself. After having made experiments on a small scale, the Author took vessels on

* From the Lond. Mechanics' Mag., April, 1860.

a large scale, had them dragged by horses, and in other ways, through the water, and by positive observations and measurement found that this was really what became of the water displaced by the bow of a boat. On one occasion he drew so large a number of boats along a canal in one direction, on a certain day, that the waves carried a great part of the water from one end of the canal to the other, and in the evening the water in the canal was found raised 18 inches at one end, and depressed to the same extent at the other. The velocity with which the traveling wave moved was found to depend entirely on the depth of the water.

At	3	feet deep	the wave travels	6	miles an hour.
"	5	"	"	8	"
"	7	"	"	10	"
"	10	"	"	12	"
"	15	"	"	15	"
"	20	"	"	18	"
"	30	"	"	20	"
"	40	"	"	25	"
"	50	"	"	30	"

In addition to a constant velocity this wave has a constant shape, a drawing of which was exhibited by the Author. And a most extraordinary circumstance was that its form corresponded exactly with the form of bow which he had previously, and from altogether different considerations, constructed as the form of least resistance. Moreover, he found that what he had endeavored to do in constructing that form, viz: move the particles of water gradually out of the way from one position of rest to another, the traveling wave also did; for on closely observing the water in the experimental trough under the action of such a wave, he observed that it lifted every particle of water over which it passed out of one place forward into another place, and there left it perfectly at rest. In the traveling wave, therefore, as in ordinary waves, the particles of water composing it were continually being replaced by others, while the wave itself advanced without apparent change. The foregoing facts convinced the Author that the form of bow which he had adopted, and which has since been called the "wave form," was analogous and conformable to the nature of water and of wave motion.

Like many others, the Author at first thought that the stern of a vessel ought to be of the same form as the bow; but thought it proper to undertake a series of experiments with the view of ascertaining what happened when a hole in the water had to be filled up. Where did the water that filled it come from? And how did it come? He first found that the hollow made in the water had no tendency to travel with an independent velocity of its own, but moved just as fast, and only as fast, as the body which produced it. He then discovered that the currents of water rushing into such a hollow, from different directions, met and produced a wave, which he called the "following wave," or the "refilling" or "replacing wave," and which always moved with the velocity of the ship, and had nothing to do with the depth of the water. The "following wave" also repeated itself in

an endless series astern of the vessel. The Author explained that the nature of this wave required that the stern of the ship should be formed of cycloidal curves, and showed how this fact was applied in actual construction.

The Author might be asked (reverting to the wave at the bow)—what became of the water at the bow supposing he dragged the boat faster than the water could spread itself? The answer was—With only a moderate force at his disposal the boat could not be made to travel faster; but if he had force enough to compel it to go in spite of the water, the water would rise up and stand on both sides of the boat until the load had passed, and then fall down into the hole left behind it. In a shallow canal in Scotland, where the carrier wave traveled only seven miles an hour, he had compelled a boat to go ten miles, and he found that the water not only rose up, but lifted the boat with it, so that she drew less water than before, and actually went easier at ten miles an hour than at five. Had not railways come into fashion just at the time, the country would have been covered with little troughs, and people would have been riding on the tops of these waves in an easier and cheaper mode than by any other means then known.

After explaining the different results which are sometimes obtained at trials in the Thames, owing to the velocities of the traveling wave varying with the depths of the water, the Author described the best means of observing the wave on rivers and other like places, and then proceeded to the application of some of the principles before laid down to practice. First, he said it was a delightful circumstance that the wave principle did not meddle at all with the form of a ship's midship section, but left the conductor entirely free to adopt any form of section he pleased. Next, it did not tie him down to any proportion of depth to breadth. It was, therefore, a plastic thing, and could be applied to any general form of ship whatever. The third and most important proposition was, that the wave-line prescribed the exact length of ship for every speed at which you wished a ship to go, and explains why a long ship is indispensable to speed. To go six miles an hour, your vessel must be at least 30 feet long; for eight miles an hour, 50 feet long; for 10 miles, 70 feet; for 12 miles, 100 feet; for 15, 150; for 18, 200; for 20, 300; for 25, 400; and for 30, 500. The Author had himself tried to obtain higher velocities than these with shorter vessels; and he had got them, but at such a fearful waste of power that it was insanity and folly not to lengthen the vessels for the purpose. The wave-line theory also told you that the length of the bow should be to that of the run as 3 to 2. The cause of this was explained.

The lines of the Great Eastern, the Author said, were neither more nor less than an exact copy of the wave-lines. The length of the bow was 330 feet; the length of the run 226 feet; and having got this length of entrance and run, and feeling that more capacity was wanted, it was of no use lengthening the bow or the run, because there was already provision for greater speed than the 15 miles an hour which

the power to be put into her could be expected to give; 120 feet of parallel body were therefore put into her amidships. The great ship might be of less fine-lines and still go with the same velocity.

There was a very valuable conclusion for practical ship-builders to be drawn, independently of what had been stated about the lines. It was this: that proportionate length and breadth were not necessary at all for a fast vessel. It was not necessary for a fast vessel that she should be a narrow, thin, long vessel in proportion to her size. The Author had taken vessels on the wave-line principle 200 feet long, and had made them of every variety of breadth, and as long as they were 200 feet long and had the lines belonging to 15 or 16 miles an hour, so long they had gone at that velocity with a given power. Further, the resistance which a vessel experiences from the sticking of water to the skin was a most formidable element of her whole resistance; and greater velocity in proportion to power would be got out of a vessel which was shorter than another, and also broader and deeper than another, providing length enough for the velocity aimed at were got at starting.

The Author's paper next contained remarks upon the effects of the wave-line upon the stability of ships—its bearing upon the load-water line—how it affected the form of the deck—how it should affect the structure of the vessel—how vessels should be built upon it so as to have a maximum of capacity—how the various proportions of length, breadth, and depth affected resistance—how the whole form could be so managed as to properly arrange the balance of the ship—how the wave-line affected the navigable qualities of a ship—how it affected the materials of which the ship should be built—and how it influenced the properties of sailing ships, paddle-steamers, and screw-steamers, respectively. But these considerations could not then be gone into. They would, however, appear in the Institution's forthcoming *Transactions*.

It was the duty of the Author, however, to say a word or two on the history of the subject, and the degree of novelty or non-novelty to which it pretended. And he begun with saying that he did not claim to be the inventor of hollow bows. They had existed as far back as he could trace steam navigation. When he had first discovered what he believed to be the principles of nature which bore on this subject, he felt that the form of vessel which accorded with them could not be new, and he set about examining all classes of vessels. He found proofs immediately; so many that he felt astonished that the books and treatises on naval architecture had not all told them to do nothing but make hollow bows from the beginning. He showed that it must have been impossible for barbarous men to have made a rough boat from two flat planks without forming such a bow. But the old tonnage laws had compelled builders to make ships of the greatest possible capacity compatible with certain measurements. Hence the bluff bow was made a matter of necessity. When, during the wars, we captured Spanish ships or privateers with fine and often hollow lines below—vessels which sailed admirably under their origi-

nal trim, in which they were down by the stern, we invariably found that they proved but dull sailers in our hands, owing undoubtedly to the fact that we not only overloaded them with weights, but trimmed them nearer to an even keel, and so brought the bluff upper part of their bows down into the water. The boats of the London watermen illustrated the same principle. The Author next alluded to the *Vesper*, built from Mr. Ditchburn's design by Fletcher and Fearnall, in which, on coming to London in 1836 or 7, he found a confirmation of the views which he had embodied in the *Wave* in 1835. He also referred to a boat built by the late Mr. Assheton Smith, and to several other vessels built successively by himself and others.

The Author concluded by stating that the rapid advancement of confidence in the wave principle was owing very much to the British Association for the Advancement of Science, which had placed at his disposal large means for the prosecution of scientific researches into this subject, and had every year enabled him to publish to the world the progress which he was making in the investigation.

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*State of Railways in Spain.**

At the close of the year 1859, the following was the state of railways in Spain, with their annual receipts:—

	Kilometres in length.	Receipts 1859. Reals vellon.
Madrid to Alicante, . . .	482	44,228,893
Madrid to Saragossa, . . .	57	2,126,720
Cordova and Seville, . . .	131	4,259,146
Valencia and Almansa, . .	138	6,430,425
Alar and Santander, . . .	91	8,540,372
Barcelona to Saragossa, . .	37	2,905,680
Barcelona to Martorell, . .	27	2,083,765
Barcelona to Arenys, . .	36	4,185,787
Barcelona to Granollers, . .	29½	2,742,050
Jerez to Trocaders, . .	27½	3,717,408
Langres and Gijon, . . .	39	
Tarragon, . . .	14	761,198
Totals, . .	1109	81,981,444

The Langres and Gijon line, in 1858, received 1,832,071 reals vellon (1*l.*=96 reals vellon).

On the Decay and Preservaton of Building Materials.† By Prof. Ansted.

Prof. Ansted commenced by directing attention to the state of the stone in many of the principal buildings in England and on the Continent, illustrating the extreme irregularity with which various materials, and even various samples of the same material, resist the action of the weather and fall into decay. He then described the chief building

* From the London Builder, No. 893.

† From the Lond. Athenæum, May, 1860.

materials, explaining in each case the cause of decay. Commencing with a general remark, that all stones are rotten and weathered at the top of a quarry or near an earthy surface, and that the action of the weather on them is in some measure thus indicated, he first alluded to granite. He stated its properties of hardness and great durability in ordinary cases; but remarked that when soda replaced potash in the felspar, the crystals of felspar were subject to the action of the weather, and that, from some cause little known, the silica base also occasionally failed. Still, the great practical objection to the use of granite is its cost. Passing next to the sandstones, he defined them, mentioning the chief varieties. He stated that the nature of decay in sandstones was generally the failure of the cementing medium, which is sometimes silicious, but more frequently calcareous, or clayey, or even oxide of iron. He pointed out as the causes of decay, the want of sufficient cohesion in the cementing medium—the nature of the cementing medium itself, and the effect of expansion and contraction of water absorbed by the stone. The limestones were next considered, and the principal varieties passed briefly under review. They are all freestones—some are crystalline, others semi-crystalline, but most of them are earthy, or oolited and absorbent. They consist of particles of carbonate of lime, whether grains, as in the case of chalk, or accumulated lumps like oolite or roe-stone, or fragments of shell; and these particles are cemented together by carbonate of lime. The stones are generally laminated, though the bedding is often extremely obscure. When exposed to the action of the air in towns, they absorb moisture and acid gases very readily, and the result is a gradual destruction of the surface, and often a rapid removal of the particles beneath the surface, especially on the planes of bedding. When stones are not placed in a building as they were in the quarry, the surface peels off in natural films, and is more rapidly acted on than it need be; but not unfrequently, even when well placed, the surface gets hardened by exposure more rapidly than the substance of the stone, and a scaling still takes place. The more exposed parts, those subject to drip and constant damp, and the more delicately sculptured portions, are among the first to decay; and, owing probably to differences in the mode or rate of deposit of the mud of which the limestone was formed, or some partial change that has since taken place, there is great irregularity in the rate of decay. Magnesian limestones, or dolomites, when quite crystalline, behave like marble; but when, as is usual, only half crystalline, they are very apt to become reduced to powder in parts, and the decay thence proceeds with extreme rapidity. The Professor next proceeded to consider the remedies for decay. He alluded to paint as at once unsightly and not permanently beneficial, and included the large class of preservatives that have been suggested, in which any animal or vegetable oil or fatty matter was contained, as equally valueless, either peeling off or rotting in the stone, and leaving it soon exposed to ordinary decay. The mineral bitumens, he stated, had not been much tried, owing to their dark, unsightly color. What is required is some mineral preparation. He then alluded to the water-

glass, a soluble silicate of potash, originally described by Dr. Fuchs, and applied to indurate stone by M. Kuhlmann. He explained the principle of this process as depending on slow decomposition by exposure to the air, and stated, that, as meanwhile the influences of the weather continued to act, the method could not be adopted with advantage in the open air in a damp climate, where preservation is chiefly required. The only plan that, as far as he was aware, met the requirements of the case, he stated to be that adopted by Mr. Ransome, according to which the absorbent surface, whether of stone or terra-cotta, was saturated with the diluted solution of soluble silicate of soda, and then treated with a solution of chloride of calcium. By the mutual action of these solutions, a double decomposition is induced, the silicic acid parting with its soda to the chlorine, producing chloride of sodium, or common salt, and combining with the lime to form silicate of lime. The salt being washed away, only the silicate of lime remains. The silicate of lime thus thrown down he next explained to be a salt, which was not only itself non-absorbent and singularly powerful in resisting the action of ordinary atmospheric influences, but as having the property of adhering rapidly to the surface of the minute particles of which stone was formed. He illustrated this by the case of mortar and concrete, which owe their adhesive properties to this habit of silicate of lime, which is the mineral formed by the mutual action of the cement on the substances in contact with it. The stone having its particles thus coated with silicate of lime, and all the absorbent surface being thus protected, the result is an immediate and great hardening of the stone, so far within its substance as the solutions have been absorbed, and a complete immunity to that extent from the action of atmospheric influences. The stone does not necessarily become non-absorbent, though it can be made so; but it absorbs much less rapidly than before, and appears to resist decay much in the way that some of the best natural sandstones, such as Craighill, are known to do.

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*Do Railway Rails ever wear out?**

At the late meeting of the West Flanders railway, Mr. Herapath having mentioned on the experience of one of our ablest practical railway men, that the rails, unless at the stations and places where there is skidding, do not sensibly wear out, was afterwards spoken to upon the subject by a gentleman, and a railway chairman, who seemed to misunderstand what Mr. Herapath said, and adduced the splitting and exfoliation of some of the rails in disproof of what they called a theory. Lest others should run away with the same mistaken notions and misapprehensions, we think it necessary to say that the non-wearing out applies to rails made with good iron, not inferior iron tinned over, as it were, with good, of which far too many rails are made, and to rails on the middle of a line over which the trains run in the ordinary way. Experiments have been made, by taking up and carefully weighing

*From Herapath's Railway Journal, No. 1091.

rails in this position after 12 months wear, or more, which were found not sensibly to have lost any weight during that time, thereby proving that there could have been no sensible wear. Besides, we have been assured that after being down for many years, they showed no signs of material wear, which justified the statement which Mr. Herapath made, on the authority given him. It is true that near stations and places of shunting where there is much sliding and slipping by the application of the brakes, or otherwise, there is very sensible wear. But this is caused by slipping friction, not rolling, which is incomparably less than the former, though it seems we have ex-railway chairmen quite innocent of the knowledge of that simple fact.

MECHANICS, PHYSICS, AND CHEMISTRY.

*New Secondary Pile of great power.** By M. G. Planté.

Jacobi proposed recently the use of secondary electric currents for telegraphic purposes, and Planté had suggested the substitution of electrodes of lead for those of platinum in these batteries. A more extended study has convinced him of their use. He states that a battery with electrodes of lead has 2½ times the electromotive force of one with electrodes of platinized platinum, and six times as great as that of one with ordinary platinum. This great power arises from the powerful affinity which peroxide of lead has for hydrogen, a fact first noticed by De la Rive. The secondary battery which he recommends has the following construction. It consists of nine elements, presenting a total surface of ten square metres. Each element is formed of two large lead plates, rolled into a spiral and separated by coarse cloth, and immersed in water acidulated with one-tenth sulphuric acid. The kind of current used to excite this battery depends on the manner in which the secondary couples are arranged. If they are arranged so as to give three elements of triple surface, five small Bunsen's cells, the zincs of which are immersed to a depth of seven centimetres, are sufficient to give, after a few minutes action, a spark of extraordinary intensity when the current is closed. The apparatus plays, in fact, just the part of a condenser; for by its means the work performed by the battery, after the lapse of a certain time, may be collected in an instant. An idea of the intensity of the charge will be obtained by remembering that to produce a similar effect it would be necessary to arrange 300 Bunsen's elements of the ordinary size (13 centimetres in height), so as to form four or five elements of 3½ square metres of surface, or three elements of still greater surface. If the secondary battery be arranged for intensity, the principal battery should be formed of a number of elements sufficient to overcome the inverse electro-motive force developed. For nine secondary elements about fifteen Bunsen's cells should be taken, which might, however, be very small.

From the malleability of the metal of which it is formed, this battery

* From the Lond. Ed. and Dub. Phil. Mag., June, 1860.

is readily constructed; by taking the plates of lead sufficiently thin, a large surface may be placed in a small space. The nine elements used by Planté are placed in a box 36 centimetres square, filled with liquid once for all, and placed in closed jars; they may also be kept charged in a physical cabinet, and ready to be used whenever it is desired to procure, by means of a weak battery, powerful discharges of dynamic electricity.—*Comptes Rendus, March 26th*, 1860.

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*Description of a Patent Blast Gas Furnace.** By J. J. Griffin, F.C.S.

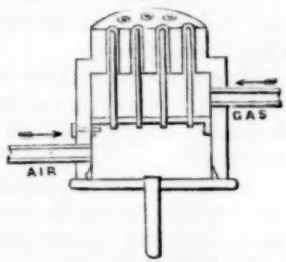
The patent blast gas furnace consists of two parts, namely, of a particular form of gas burner, which is supplied with gas at the usual pressure, and with a blast of common air, supplied by bellows or a blowing machine, at about ten times the pressure at which the gas is supplied.

Secondly, of a furnace which is built up in a particular manner, round the flame that is produced by the gas-burner, and the crucible that is exposed to ignition. The object of the particular construction of this furnace is to accumulate and concentrate in a focus the heat produced by the gas flame, and to make it expend its entire power upon any object placed in that focus.

This apparatus can be made of various sizes, according to the amount of work which is required from it. We describe below a few varieties of the furnace, and the results of some experiments made with them, which will show the reader what kind of work it is able to execute.

The Gas-burner.—The gas-burner is a cylindrical iron reservoir, containing two chambers, which are not in communication with one another. Into the upper chamber, gas is allowed to pass; and into the lower chamber, air is forced by means of tubes. The upper part of the burner is an inch thick in the metal. Through this solid roof, holes are bored for the escape of the gas. The experiments described hereafter were made with a burner that contained sixteen holes; but burners with six holes, and with twenty-six holes, have been made for other purposes. The number of holes depends, of course, upon the heating power required from the burners. The air passes from the lower chamber, through a series of metal tubes, placed in the centre of the gas-holes, and continued to the surface of the burner, so that the gas and air do not mix until both have left the gas-burner, and then a current of air is blown through the middle of each jet of gas. The bottom of the gas-burner is made to unscrew, and the division between the two chambers, which carries the air-tubes, is easily removable, for the purpose of being cleaned. The gas and

Fig. 1.



* From the London Chemical News, No. 3.

air pipes are both half an inch in the bore, and are ten inches long; the gas has usually had a pressure of half an inch of water, and the blast of air about ten times that pressure. The quantity of gas used in an hour was about 100 cubic feet. The stop-cock which supplied it had a bore of half an inch.

When the gas is lighted and the blast of air is put on, the flame produced by the gas-burner is quite blue and free from smoke. It is two inches in diameter, and three inches high, and the point of greatest heat is about two inches above the flat face of the gas-burner. Above this steady blue flame there rises a flickering ragged flame several inches in height, varying with the pressure of the gas. In the blue flame thin platinum wires fuse readily.

When the gas is burning in this manner, and the apparatus is attached to flexible tubes, the burner may be inverted or held sideways, without disturbing the force or regularity of the flame, so that the flame may be directed into a furnace at the bottom, the top, or the side, as circumstances may require.

The following articles are used in building up a gas furnace for different experiments. They vary in size according to the volume of the crucible, or the weight of the metal which is to be heated.

1. A circular plate of fire-clay, two inches thick, with a hole in the centre, which exactly fits the upper part of the gas-burner, which is made to enter into the hole three-quarters of an inch. In external diameter, this clay plate agrees with each size of furnace.

2. A cylinder of fire-clay, of which two pieces are required to constitute the body of each furnace. In the middle of each cylinder, a trial hole is made, one inch in diameter, to which a fire-clay stopper is adapted.

3. A fire-clay cylinder, closed at one end and pierced near the open end with six holes, of half an inch in diameter. The thickness of the clay is immaterial.

This cylinder is three inches high and three inches in diameter.

4. A circular plate of fire-clay, two and a half inches or three inches in diameter, and one inch thick. Similar pieces half an inch thick are useful.

5. A cylinder of plumbago, to be used as a crucible support. It is three inches inside diameter and one inch in height. It is pierced with twelve holes of three-eighths of an inch bore.

6. A similar cylinder of plumbago, two inches high, pierced with twenty-four holes of three-eighths of an inch bore.

7. A thin plate of plumbago, three inches in diameter, namely, of the same diameter as the above three cylinders. It has a small hole in the middle, and being of soft material, the hole can be easily cut or filed to suit crucibles of any desired size.

To suit the larger kinds of crucibles and furnaces, cylinders are made resembling the above in form, but of greater diameter.

As in all cases the heating power of the gas furnace spreads laterally and does not rise vertically, the most advisable form of the crucibles required for use in it is *short and broad*, not tall and narrow, and the

snpporting cylinders must be shaped accordingly. No fire-bars or grates can be used to support crucibles in this gas furnace, because no material formed into narrow bars can sufficiently withstand its powers of fusion and combustion.

8. A plumbago cylinder, or crucible-jacket, two and a half inches high, two and a half inches in diameter, and a quarter of an inch thick in the walls. It has six holes of three-eighths of an inch diameter near one end.

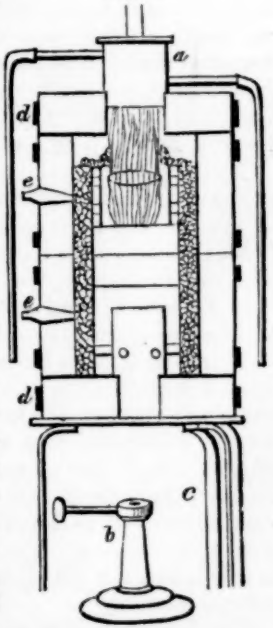
9. A circular cover or dome, flanched at the bottom, and having a knob or handle at the top. It is pierced with twenty-four holes of a quarter of an inch in diameter, arranged in two rows near the bottom. This dome, when of small size, is made of plumbago. When of large size, of fire-clay.

10. Plumbago crucibles made with a solid overhanging rim, the use of which is to suspend the crucibles over the gas-burner, by means of the cylinders Nos. 5 and 6. When the crucibles are too small to fit the cylinders, the flat plate (No. 7) is filed to fit the crucible, and is then placed on the cylinder, to whose diameter it is adapted.

Besides these pieces of fire-clay and plumbago, it is necessary to be provided with a strong iron tripod to sustain the furnace; an iron pan in which to place the furnace; and a quantity of gravel, or rounded flints, not less than half an inch, nor more than one inch in diameter. These pebbles form an essential part of this gas furnace.

Gas Furnace, heated at the top, exhibited in section by Fig. 2.—*a* is the gas-burner (Fig. 1); *b* is the support for it when used below the furnace; *c* is the iron tripod support for the furnace; *d d* are two perforated clay plates (No. 1) adapted to the gas-burner *a*; *e e* are two clay cylinders like No. 2. These pieces, *a* to *e*, are similar in all the furnaces and will not require description in each example.

Fig. 2.



The interior of the furnace, as represented by Fig. 2, is built up as follows:—The clay plate *d*, is put upon the tripod *c*. Over the central hole in *d*, the clay cylinder (No. 3) is placed, and upon that cylinder two or three of the clay plates (No. 4). Upon these a porcelain or platinum crucible is placed. If it is of platinum, a piece of platinum foil may be put between the crucible and the uppermost clay plate to protect the crucible from contact with particles of iron, or against fusion with the clay. The crucible is to be covered by the plumbago jacket, No. 8. The space between this pile in the centre of the furnace and the two cylinders *ee*, which form the walls of the furnace, is to be filled with flint stones, or

gravel, washed clean and dried. The stones which answer best are rounded, water-worn pebbles of half an inch to one inch diameter. These may be piled up to the top edge of the jacket (No. 8). The number of clay plates (No. 4) must be such as to bring the top of the crucible to the distance of two inches, or two and a half inches at the utmost, from the flat face of the gas-burner *a*. In some cases, merely one of the furnace cylinders *e* is necessary, in which case the crucible and its jacket is placed directly upon the cylinder (No. 3), and when only a moderate heat is required, even the packing with pebbles may be dispensed with. Another means of diminishing the heat is that of increasing the distance between the gas-burner and the crucible.

The apparatus being thus arranged, the gas is to be turned on, and to be lighted, the blowing machine is to be put into action, and the nozzle of the gas-burner is to be depressed into the central hole of the clay plate *d*. The whole force of the blue flame then strikes the crucible; part of it forces its way through the holes in the jacket (No. 8), and part of it rises and passes over the upper edge of the jacket; after which it forces its way downwards between the pebbles. The carbonic acid gas and the vapor of water which result from the combustion of the gas, together with the nitrogen of the air, and any uncombined oxygen, accompany it. No space being left open for the escape of these gases at the upper end of the furnace, they go downwards through the interstices among the pebbles, and passing through the holes in the cylinder (No. 3), and through the central hole in the lower plate *d*, they escape finally into the air. In this progress the hot gases give up nearly all their heat to the flint stones. Water and gases escape below at a very moderate temperature, water even runs down in the liquid state, while the stones rapidly acquire a white heat, and if the blast and the supply of gas is continued, they retain that white heat for any desired length of time—for hours.

At the end of ten minutes after lighting the gas, the crucible, placed in the desired circumstances, and exposed to the full action of the heat of the gas, and surrounded by substances which are bad conductors of heat, is raised, with the jacket and pebbles around it, to a white heat. The consequence is, that the full power of the gas-jet is then exerted upon the crucible and its contents, and those effects are produced which will be described presently.

If it is desired to inspect the substances subjected to the action of heat in this furnace, the gas-burner is lifted out, and the crucible is examined through the hole in the clay plate. To make it possible to inspect substances at a white heat, the view is taken through a piece of dark cobalt blue glass. If the substances submitted to heat suffer no harm from the action of oxygen, it is better to dispense with a crucible cover, and to direct the jet of flame directly down upon the substance to be heated. The action is then more rapid. When the burner is taken out, the substance in the crucible can be stirred, if it is considered necessary.

The following experiment will give an idea of the power of a furnace of this description. A common clay crucible, three inches high and

three inches diameter at the mouth, was filled with about 24 ounces of cast iron. It was mounted as in Fig. 2, in a furnace of four inches internal diameter, and eight inches deep. The pebbles were filled in to the edge of the crucible. No crucible cover and no jacket were used. The flame was thrown directly upon the iron. In a short time the iron melted, the oxygen then converted some of the cast iron into magnetic oxide of iron, which formed a thin, infusible mass on the surface of the cast iron. At twenty minutes from the lighting of the gas, the furnace was dismounted. The crucible was taken out. A hole was broken by an iron rod in the infusible surface of oxidized iron, and the fused cast iron below it was decanted into a mould, and made a clear casting weighing twenty ounces.

In the same small furnace 32 ounces of copper can be fused in 15 minutes. When the furnace is hot, that quantity of copper or cast iron can be fused in 10 minutes.

In a furnace of the same dimensions, but with a gas-burner having only six, instead of sixteen jets, 16 ounces of copper or of cast iron can be completely fused in ten minutes if the furnace is cold, and in seven minutes if the furnace is hot.

These experiments show that within twenty minutes a heat is producible in this little furnace which is more than sufficient for the decomposition of silicates by fusion with the carbonates of potash, soda, or barytes.

(To be Continued.)

Serrin's Automatic Regulator for Electric Lamps.

The two tubes which carry the carbons are placed vertically, the one over the other; and communicate, the upper with the positive pole of the battery, the lower, by means of a train of wheels and the oscillating apparatus, with the negative pole. When the positive carbon descends by its own weight, it lifts the negative carbon through one-half of the distance, so that, as the negative carbon wastes only one-half as fast as the positive, the light is kept in the same place. The oscillating apparatus is a jointed rectangle, two of whose sides are vertical, the others horizontal; one of the vertical sides is fixed, and the other is movable and very delicately suspended so that it may either descend by its own weight or rise by the power of a spring which presses it upward. The apparatus carries at its lower part a soft iron armature corresponding with an electro-magnet operated on by the current of the battery.

When the current is not passing, the carbons are in contact; but as soon as the current is closed, the magnet becomes active, the armature is drawn down, the oscillator sinks carrying with it the negative carbon, which thus separates from the positive carbon which remains in its place, then the light appears between the points. As the carbons are consumed, their distance apart increases, the current is enfeebled, the magnet is weaker, the armature less attracted, and the oscillator rises; in rising, it disengages the train and the carbons approach each

other. As the apparatus is very sensitive, these are rather tendencies to movement or change, than actual changes. If an accident should happen, if one or both of the carbons should break, the current is suddenly interrupted, the magnet ceases to act, the oscillator rises, and allows the train to start and replace the carbons in their proper positions. The play of this apparatus is so steady and easy that it will work with the alternating currents from the electro-magnetic machine. The lamp is lighted or extinguished the moment the current is established or interrupted. The lamp, therefore, becomes very suitable for telegraphic signals or for light-houses, in which, by these means, the flashes may be obtained without any mechanism for rotation.—*Academy of Sciences of Paris.—Cosmos.*

Mode of Etching on Glass.

A painter at *Bourg-en-Bresse* in France, reports to the *Cosmos* the following singular and valuable experiment: He traced upon a piece of glass a design in white-lead mixed with linseed-oil, and when it had dried, he laid it for a few minutes over a vessel in which hydro-fluoric was generating. When the glass was removed, it was found that the parts of the glass covered by the white paint were etched, while those uncovered had not been attacked. Should this observation be confirmed, it would seem to open a new field to glass-etchers.

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*Loss of Light by Glass Shades.** By WILLIAM KING.

SIR:—Having recently tried some experiments, for the purpose of ascertaining the amount of light lost by the use of various descriptions of glass shades, I thought that the results obtained might not prove uninteresting to some of your readers, more especially as it is a subject of practical importance, and does not seem to have attracted the notice which it deserves.

The following table exhibits the amount of light lost by the use of the various shades therein enumerated:—

Description of shade.	Loss of light.
Clear glass,	10·57 per cent.
Ground glass (entire surface ground),	29·48 "
Smooth opal,	52·83 "
Ground opal,	55 85 "
Ground opal, ornamented with painted figures, the figures intervening between the burner and the photometer screen,	73·98 "

As the large amount of light lost by the use of a clear glass shade excited some surprise, a sheet of common window glass was placed between the burner and the photometer screen, when it was found that 9·34 per cent. of the light was intercepted, thus confirming the result obtained by the employment of a shade of clear glass.

I may state that the shades were selected from a large number, and great pains were taken to obtain an average specimen of each kind.

Liverpool, Feb. 24, 1860.

*From the Lond. Jour. of Gas Lighting, &c., No. 192.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.** By M. FARADAY, D. C. L., F. R. S.,

LECTURE II. (Jan. 3, 1860.)—*Gravitation.—Cohesion.*

Do me the favor to pay me as much attention as you did at our last meeting, and I shall not repent of that which I have proposed to undertake. It will be impossible for us to consider the Laws of Nature, and what they effect, unless we now and then give our sole attention, so as to obtain a clear idea upon the subject. Give me now that attention, and then I trust we shall not part without your knowing something about those Laws, and the manner in which they act. You recollect, upon the last occasion, I explained that all bodies attracted each other, and that this power we called *gravitation*. I told you that when we brought these two bodies [two equal sized ivory balls suspended by threads] near together they attracted each other, and that we might suppose that the whole power of this attraction was exerted between their respective centres of gravity; and, furthermore, you learned from me that if, instead of a small ball, I took a larger one, like *that* [changing one of the balls for a much larger one], there was much more of this attraction exerted; or, if I made this ball larger and larger, until, if it were possible, it became as large as the Earth itself—or I might take the Earth itself as the large ball—that *then* the attraction would become so powerful as to cause them to rush together in this manner [dropping the ivory ball]. You sit *there* upright, and I stand upright *here*, because we keep our centres of gravity properly balanced with respect to the earth; and I need not tell you that on the other side of this world the people are standing and moving about with their feet towards our feet, in a reversed position as compared with us, and all by means of this power of gravitation to the centre of the earth.

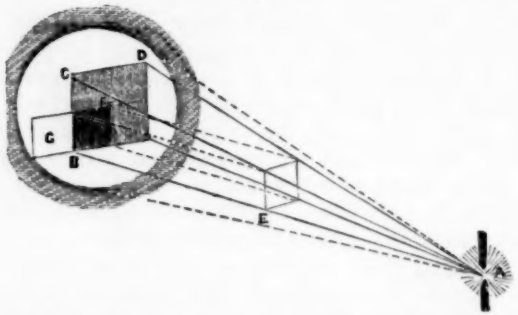
I must not, however, leave the subject of gravitation without telling you something about its laws and regularity; and first, as regards its power with respect to the distance the bodies are apart. If I take one of these balls and place it within an inch of the other, they attract each other with a certain power. If I hold it at a greater distance off, they attract with less power, and if I hold it at a greater distance still, their attraction is still less. Now this fact is of the greatest consequence; for, knowing this law, philosophers have discovered most wonderful things. You know that there is a planet, Uranus, revolving round the sun with us, but eighteen hundred millions of miles off; and because there is another planet as far off as three thousand millions of miles, this law of attraction, or gravitation, still holds good, and philosophers actually discovered this latter planet, Neptune, by reason of the effects of its attraction at this overwhelming distance. Now I want you clearly to understand what this law is. They say (and they are right) that two bodies attract each other *inversely as the square of the distance*,—a sad jumble of words until you understand them; but I think we shall

* From the Lond. Chemical News, No. 6.

soon comprehend what this law is, and what is the meaning of the "inverse square of the distance."

I have here (Fig. 1) a lamp A, shining most intensely upon this disc BCD, and this light acts as a sun by which I can get a shadow from

Fig. 1.

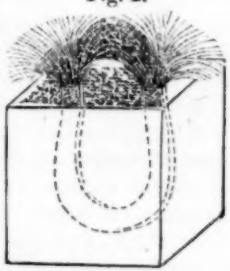


this little screen BF (merely a square piece of card), which, as you know, when I place it close to the large screen, just shadows as much of it as is exactly equal to its own size; but now let me take this card E, which is equal to the other one in size, and place it midway between the lamp and the screen; now look at the size of the shadow BD, it is four times the original size. Here, then, comes the "inverse square of the distance." This distance AE, is *one*, and that distance AB, is *two*, but that size E, being *one*, this size BD of shadow is *four* instead of *two*, which is the *square* of the distance; and if I put the screen at one-third of the distance from the lamp, the shadow on the large screen would be *nine* times the size. Again, if I hold this screen *here* at BF, a certain amount of light falls on it; and if I hold it nearer the lamp at E, *more* light shines upon it. And you see at once how much—exactly the quantity which I have shut off from the part of this screen BD, now in shadow; moreover, you see that if I put a single screen here at G, by the side of the shadow, it can only receive *one-fourth* of the proportion of light which is obstructed. That, then, is what is meant by the *inverse* of the square of the distance. This screen E, is the brightest because it is the nearest, and there is the whole secret of this curious expression *inversely as the square of the distance.* Now, if you cannot perfectly recollect that when you go home, get a candle and throw a shadow of something—your profile, if you like—on the wall, and then recede or advance, and you will find that your shadow is exactly in proportion to the *square* of the distance you are off the wall; and then if you consider how much light shines on you at one distance, and how much at another, you get the inverse accordingly. So it is as regards the attraction of these two balls, they attract according to the square of the the distance, inversely. I want you to try and remember these words, and then you will be able to go into all the calculations of astronomers, as to the planets and other bodies, and tell why they move so fast, and why they go *round* the sun without falling into it, with many other curious things.

Let us now leave this subject which I have written upon the board under the word FORCE—GRAVITATION—and go a step further. All bodies attract each other at sensible distances. I showed you the electric attraction on the last occasion (though I did not call it so); that attracts at a distance; and in order to make our progress a little more simple, suppose I take a few iron particles [dropping some small fragments of iron on the table]. There, I have already told you that in all cases where bodies fall, it is the *particles* that are attracted. You may consider these, then, as separate particles magnified, so as to be evident to your sight; they are loose from each other—they all gravitate—they all fall to the earth—for the force of gravitation *never* fails. Now, I have here a centre of power which I will not name at present, and when these particles are placed upon it, see what an attraction they have for each other.

Here I have an arch of iron filings (Fig. 2) regularly built up like an iron bridge, because I have put them within a sphere of action which will cause them to attract each other. See!—I could let a mouse run through it, and yet if I try to do the same thing with them *here* [on the table] they do not attract each other at all. It is *that* [the magnet] which makes them hold together. Now just as these iron particles hold together in the form of an elliptical bridge, so do the different particles of iron which constitute this nail hold together and make it one. And here is a bar of iron; why, it is only because the different parts of *this* iron are so wrought as to keep close together by the attraction *between* the particles, that it is held together in one mass. It is kept together, in fact, merely by the attraction of one particle to another, and that is the point I want now to illustrate. If I take a piece of flint and strike it with a hammer and break it thus [breaking off a piece of the flint], I have done nothing more than separate the particles which compose these two pieces so far apart, that their attraction is too weak to cause them to hold together, and it is only for that reason that there are now two pieces in the place of one. I will show you an experiment to prove that this attraction does still exist in those particles, for here is a piece of glass (for what was true of the flint and the bar of iron is true of the piece of glass, and is true of every other solid, they are all held together in the lump by the attraction between their parts), and I can show you the attraction between its separate particles, for if I take these portions of glass which I have reduced to a very fine powder, you see that I can actually build them up into a solid wall by pressure between two flat surfaces. The power which I thus have of building up this wall is due to the attraction of the particles, forming, as it were, the cement which holds them together; and so in this case, where I have taken no very great pains to bring the particles together, you see, perhaps a couple of ounces of finely pounded glass standing as an upright wall—is not this attraction most wonderful? *That* bar of iron

Fig. 2.



one inch square has such power of attraction in its particles—giving to it such strength—that it will hold up twenty tons weight before the little set of particles in the small space equal to one division across which it can be pulled apart, will separate. In this manner suspension bridges and chains are held together by the attraction of their particles, and I am going to make an experiment which will show how strong is this attraction of the particles—do not think me a harlequin or fairy. [The Lecturer here placed his foot on a loop of wire fastened to a support above, and swung with his whole weight resting upon it for some moments.] You see, while hanging here all my weight is supported by these little particles of the wire, just as in pantomimes they sometimes suspend gentlemen and damsels.

Now how can we make this attraction of the particles a little more simple? There are many things which if brought together properly will show this attraction. Here is a boy's experiment (and I like a boy's experiment).—Get a tobacco-pipe, fill it with lead, melt it, and then pour it out upon a stone, and thus get a clean piece of lead (this is a better plan than scraping it—scraping alters the condition of the surface of the lead). I have here some pieces of lead which I melted this morning for the sake of making them clean. Now these pieces of lead hang together by the attraction of their particles, and if I press these two separate pieces close together, so as to bring their particles within the sphere of attraction, you will see how soon they become one. I have merely got to give them a good squeeze, and draw the upper piece slightly round at the same time, and here they are as one, and all the bending and twisting I can give them will not make them separate again; I have joined the lead together, not with solder, but simply by means of the attraction of the particles.

This, however, is not the best way of bringing those particles together, we have many better plans than that—and I will show you one that will do very well for juvenile experiments. There is some alum crystallized very beautifully by nature (for all things are far more beautiful in their natural than their artificial form), and here I have some of the same alum broken into fine powder. In it I have destroyed that force of which I have placed the name on this board—COHESION, or the attraction exerted between the particles of bodies to hold them together. Now I am going to show you that if we take this powdered alum and some hot water, and mix them together, I shall dissolve the alum—all the particles will be separated by the water far more completely than they are here in the powder; but then, being in the water, they will have the opportunity as it cools (for that is the condition which favors their coalescence) of uniting together again and forming one mass.

Now having brought the alum into solution, I will pour it into this glass basin, and you will, to-morrow, find that those particles of alum which I have put into the water, and so separated that they are no longer solid, will as the water cools, come together and cohere, and by to-morrow morning we shall have a great deal of the alum crystallized out, that is to say, come back to the solid form. [The Lecturer

here poured a little of the hot solution of alum into the glass dish, and when the latter had thus been made warm, the remainder of the solution was added.] I am now doing that which I advise you to do if you use a glass vessel, namely, warming it slowly and gradually; and in repeating this experiment do as I do; pour the liquid out gently, leaving all the dirt behind in the basin; and remember that the more carefully and quietly you make this experiment at home, the better the crystals. To-morrow you will see the particles of alum drawn together, and if I put two pieces of coke in some part of the solution (the coke ought first to be washed very clean and dried), you will find to-morrow that we shall have a beautiful crystallization over the coke, making it exactly resemble a natural mineral.

Now how curiously our ideas expand by watching these conditions of the attraction of cohesion—how many new phenomena it gives us beyond those of the attraction of gravitation. See how it gives us great strength. The things we deal with in building up the structures on the earth are of strength—we use iron, stone, and other things of great strength; and only think that all those structures you have about you—think of the *Great Eastern*, if you please, which is of such size and power as to be almost more than man can manage—are the result of this power of cohesion and attraction.

I have here a body in which I believe you will see a change taking place in its condition of cohesion at the moment it is made. It is at first yellow, then it becomes a fine crimson red. Just watch when I pour these two liquids together—both colorless as water. [The Lecturer here mixed together solutions of perchloride of mercury and iodide of potassium, when a yellow precipitate of biniodide of mercury fell down, which almost immediately became crimson red.] Now, there is a substance which is very beautiful, but see how it is changing color. It was reddish-yellow at first, but it has now become red. I have previously prepared a little of this red substance, which you see formed in the liquid, and have put some of it upon paper. [Exhibiting several sheets of paper coated with scarlet biniodide of mercury.] There it is—the same substance spread upon paper, and there too is the same substance; and here is some more of it [exhibiting a piece of paper as large as the other sheets, but having only very little red color on it, the greater part being yellow], a *little* more of it, you will say. Do not be mistaken; there is as much upon the surface of one of these pieces of paper as upon the other. What you see yellow is the same thing as the red body, only the attraction of cohesion is in a certain degree changed; for I will take this red body, and apply heat to it (you may perhaps see a little smoke arise, but that is of no consequence), and if you look at it, it will at first of all darken—but see, how it is becoming yellow. I have now made it all yellow, and what is more it will remain so; but if I take any hard substance and rub the yellow part with it, it will immediately go back again to the red condition. [Exhibiting the experiment.] There it is. You see the red is not *put back*, but *brought back* by the change in the substance. Now [warming it over the spirit lamp] here it is becoming yellow again,

and that is all because its attraction of cohesion is changed. And what will you say to me when I tell you that this piece of common charcoal is just the same thing, only differently coalesced, as the diamonds which you wear. (I have put a specimen outside of a piece of straw which was charred in a particular way—it is just like black lead.) Now, this charred straw, this charcoal, and these diamonds, are all of them the same substance, changed but in their properties as respects the force of cohesion.

Here is a piece of glass [producing a piece of plate glass about two inches square], (I shall want this afterwards to look at and examine its internal condition)—and here is some of the same sort of glass differing only in its power of cohesion, because while yet melted it has been dropped into cold water [exhibiting a "Prince Rupert's drop" (Fig. 3)], and if I take one of these little tear-like pieces and break off ever so little from the point, the whole will at once burst and fall to pieces. I will now break off a piece of this. [The Lecturer nipped off a small piece from the end of one of the Rupert's drops, whereupon the whole immediately fell to pieces.] There! you see the solid glass has suddenly become powder, and more than that, it has knocked a hole in the glass vessel in which it was held. I can show the effect better in this bottle of water, and it is very likely the whole bottle will go. [A 6-oz. vial was filled with water, and a Rupert's drop placed in it with the point of the tail just projecting out; upon breaking the tip off, the drop burst, and the shock being transmitted through the water to the sides of the bottle, shattered the latter to pieces.]

Here is another form of the same kind of experiment. I have here some more glass which has not been annealed, [showing some thick glass vessels (Figure 4)], and if I take one of these glass vessels and drop a piece of pounded glass into it (or I will take some of these small pieces of rock crystal—they have the advantage of being harder than glass) and so will make the least scratch upon the inside, the whole bottle will break to pieces,—it cannot hold together. [The Lecturer here dropped a small fragment of rock crystal into one of these glass vessels, when the bottom immediately came out and fell upon the plate.] There it goes through, just as it would through a sieve.

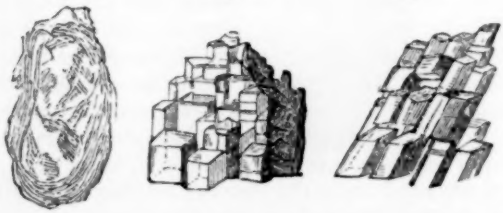
Fig 3.

Fig. 4.

Now, I have shown you these things for the purpose of bringing your minds to see that bodies are not merely held together by this power of cohesion, but that they are held together in very curious ways. And suppose I take some things that are held together by this force, and examine them more minutely. I will first take a bit of glass, and if I give it a blow with a hammer I shall just break it to pieces. You saw how it was in the case of the flint when I broke a piece off; a piece of a similar kind would come off, just as you would expect; and if I were to break it up still more, it would be as you

have seen, simply a collection of small particles of no definite shape or form. But supposing I take some other thing, this stone for instance (Fig. 5) [taking a piece of mica], and if I hammer this stone I may batter it a great deal before I can break it up. I may even bend it without breaking it; that is to say, I may bend it in *one particular direction* without breaking it much, although I feel in my hands that I am doing it some injury. But now, if I take it by the edges I find that it breaks up into leaf after leaf in a most extraordinary manner. Why should it break up like that? Not because all stones do, or all crystals; for there is some salt—(Fig. 6)—you know what com-

Fig. 5. Fig. 6. Fig. 7.

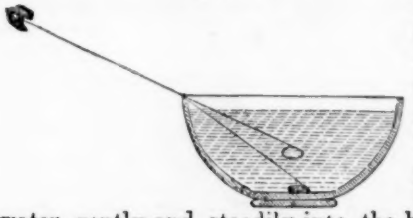


mon salt is; here is a piece of this salt which by natural circumstances has had its particles so brought together that they have been allowed free opportunity of combining or coalescing, and you shall see what happens if I take this piece of salt and break it. It does not break as flint did, or as the mica did, but with a clean sharp angle and exact surfaces, beautiful and glittering as diamonds [breaking it by gentle blows with a hammer]; there is a square prism which I may break up into a square tube. You see these fragments are all square—one side may be longer than the other, but they will only split up so as to form square or oblong pieces with cubical sides. Now, I go a little further, and I find another stone (Fig. 7) [Iceland or calc-spar], which I may break in a similar way, but *not* with the same result. Here is a piece which I have broken off, and you see there are plain surfaces perfectly regular with respect to each other, but it is not cubical—it is what we call a rhomboid. It still breaks in three directions most beautifully and regularly with polished surfaces, but with *sloping* sides, not like the salt. Why not? It is very manifest that this is owing to the attraction of the particles one for the other being less in the direction in which they give way than in other directions. I have on the table before me a number of little bits of calcareous spar, and I recommend each of you to take a piece home, and then you can take a knife and try to divide it in the direction of any of the surfaces already existing. You will be able to do it at once—but if you try to cut it *across* the crystals you cannot; by hammering, you may bruise and break it up—but you cannot divide it into these beautiful little rhomboids.

Now I want you to understand a little more how this is—and for this purpose I am going to use the electric light again. You see, we cannot look into the *middle* of a body like this piece of glass. We

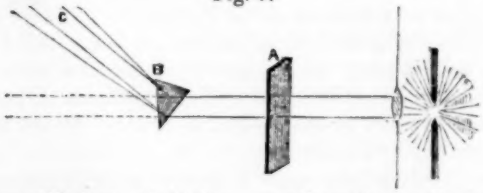
perceive the outside form, and the inside form, and we look *through* it, but we cannot well find out how these forms become so, and I want you, therefore, to take a lesson in the way in which we use a ray of light for the purpose of seeing what is in the interior of bodies. Light is a thing which is, so to say, attracted by every substance that gravitates (and we do not know anything that does not). All matter affects light more or less by what we may consider as a kind of attraction, and I have arranged (Fig. 8) a very simple experiment upon the floor of the room for the purpose of illustrating this. I have put into that basin a few things which those who are in the body of the theatre will not be able to see, and I am going to make use of this power which matter possesses of attracting a ray of light. If Mr. Anderson pours some water gently and steadily into the basin, the water will attract the rays of light downwards, and the piece of sealing wax will appear to rise up into the sight of those who were before not high enough to see over the side of the basin to its bottom. [Mr. Anderson here poured water into the basin, and upon the Lecturer asking whether anybody could see the silver and sealing wax he was answered by a general affirmative]. Now I suppose that everybody can see that they are not at all disturbed, whilst from the way they appear to have risen up, you would imagine the bottom of the basin and the articles that are in it were two inches thick, although they are only one of our small silver dishes and a piece of sealing wax which I have put there. The light which now goes to you from that piece of silver was obstructed by the edge of the basin when there was no water there, and you were unable to see anything of it; but when we poured in water, the rays were attracted down by it over the edge of the basin, and you were thus enabled to see the articles at the bottom.

Fig. 8.



I have shown you this experiment first, so that you might understand how glass attracts light, and might then see how other substances like rock salt and calcareous spar, mica, and other stones would affect the light; and if Dr. Tyndall will be good enough to let us use his light again, we will first of all show you how it may be bent by a piece of glass (Fig. 9). [The electric lamp was again lit, and the beam of parallel rays of light which it emitted was bent about and decomposed by means of the prism.] Now here you see, if I send the light through

Fig. 9.



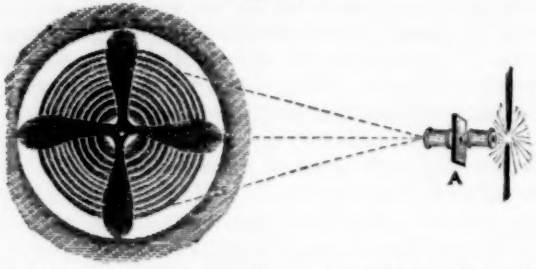
this piece of plain glass A, it goes straight through without being bent (unless the glass be held obliquely, and then the phenomenon becomes more complicated), but if I take this piece of glass B [a prism], you see it will show a very different effect. It no longer goes to that wall but it is bent to this screen C, and how much more beautiful it is now [throwing the prismatic spectrum on the screen.] This ray of light is bent out of its course by the attraction of the glass upon it. And you see I can turn and twist the rays to and fro in different parts of the room just as I please. Now it goes there, now here. [The Lecturer projected the prismatic spectrum about the theatre.] Here I have the rays once more bent on the screen, and you see how wonderfully and beautifully that piece of glass not only bends the light by virtue of its attraction, but actually splits it up into different colors. Now I want you to understand that this piece of glass [the prism] being perfectly uniform in its internal structure, tells us about the action of these other bodies which are not uniform—which do not merely *cohere*, but also have within them, in different parts, different *degrees of cohesion*, and thus attract and bend the light with varying powers. We will now let the light pass through one or two of these things which I just now showed you broke so curiously; and first of all I will take a piece of mica. Here you see is our ray of light—we have first to make it what we call *polarized*, but about that you need not trouble yourselves, it is only to make our illustration more clear. Here, then, we have our polarized ray of light, and I can so adjust it as to make the screen upon which it is shining either light or dark, although I have nothing in the course of this ray of light but what is perfectly transparent [turning the *analizer* round]. I will now make it so that it is quite dark, and we will in the first instance put a piece of common glass into the polarized ray so as to show you that it does not enable the light to get through. You see the screen remains dark. The glass then, internally, has no effect upon the light. [The glass was removed, and a piece of mica introduced.] Now, there is the mica which we split up so curiously into leaf after leaf, and see how that enables the light to pass through on to the screen, and how, as Dr. Tyndall turns it round in his hand, you have those different colors, pink, and purple, and green, coming and going most beautifully;—not that the mica is more transparent than the glass, but because of the different manner in which its particles are arranged by the force of cohesion.

Now we will see how calcareous spar acts upon this light,—that stone which split up into rhombs, and of which you are going to take a little piece home each of you. [The mica was removed, and a piece of calc-spar introduced at A.] See how that turns the light round and round, and produces these rings and that black cross (Fig. 10). Look at those colors, are they not most beautiful for you and for me? (for I enjoy these things as much as you do.) In what a wonderful manner they open out to us the internal arrangement of the particles of this calcareous spar by the force of cohesion.

And now I will show you another experiment. Here is that piece

of glass which before had no action upon the light. You shall see what it will do when we apply pressure to it. Here, then, we have our ray of polarized light, and I will first of all show you that the glass has no effect upon it in its ordinary state,—when I place it in the

Fig. 10.



course of the light, the screen still remains dark. Now Dr. Tyndall will press that bit of glass between three little points, one point against two, so as to bring a strain upon the parts, and you will see what a curious effect that has. [Upon the screen two white dots gradually appeared.] Ah! these points show the position of the strain—in these parts the force of cohesion is being exerted in a different degree to what it is in the other parts, and hence it allows the light to pass through. How beautiful that is—how it makes the light come through some parts and leaves it dark in others, and all because we weaken the force of cohesion between particle and particle. Whether you have this mechanical power of straining, or whether we take other means, we get the same result, and, indeed, I will show you by another experiment that if we heat the glass in one part it will alter its internal structure, and produce a similar effect. Here is a piece of common glass, and if I insert this in the path of the polarized ray, I believe it will do nothing. There is the common glass [introducing it]—no light passes through—the screen remains quite dark; but I am going to warm this glass in the lamp, and you know yourselves that when you pour warm water upon glass you put a strain upon it sufficient to break it sometimes—something like there was in the case of the Prince Rupert's drops. [The glass was warmed in the spirit lamp, and again placed across the ray of light.] Now you see how beautifully the light goes through those parts which are hot, making dark and light lines just as the crystal did, and all because of the alteration I have effected in its internal condition; for these dark and light parts are a proof of the presence of forces acting and dragging in different directions within the solid mass.

(To be Continued.)

Methods of Ripening Wine.

According to the *Cosmos*, M. Payen, a distinguished French chemist, has the credit of proposing the following methods of ripening wine:

First Method. Take a cask of wine, and expose it to cold in a clean

vat; remove every morning, for three or four days successively, the ice which has formed on the surface; the ice, when melted, will furnish *piquette;* and the remaining liquid will be an excellent wine.—Re-pour it into a cask; add to perfume it, say a quart of raspberry juice, or two cents worth of Florence flag-root powdered and first digested in wine, cork it up tight and keep it.—(*If you can.* ED. J. F. I.)

Second Method. In March or April take second-crop hay or straw; make a bed of it about 8 inches thick, upon which lay a first row of bottles corked and waxed; and build up the pile in this way: water the pile with common water so that the hay may ferment, rot, and dissolve. At the end of three or four months your wine will have the same flavor as though it had been three or four years in bottle.

Cosmos, March, 1860.

For the Journal of the Franklin Institute.

Cadmium. By B. WOOD, M. D.

The properties of cadmium appear to have been less clearly determined by chemists and metallurgists than those of most other metals. Discrepancies exist in regard to it, while some of its most remarkable, if not most useful properties are not at all noticed, at least by the generality of authors, even when explicit and elaborate as to similar properties possessed by other metals. Our ordinary works on chemistry treat of the metal very briefly, as of little importance—one of the latest says, it "has *no* practical value in the arts:"—but if duly investigated it will be found, I think, to possess qualities highly useful to the arts as well as interesting to science.

The melting point of cadmium is variously stated by authors. Some place it indefinitely, "below a red heat." Overman in his Treatise on Metallurgy, marks it at 550° Fahr., and indicates 600° as the temperature at which the metal volatilizes. Brande, Dict. Science and Art, says "it fuses and volatilizes at a temperature a little below that at which tin melts." Webster, Manual of Chemistry, states that "it melts and volatilizes by a heat not much greater than that required to vaporize mercury." Most of our chemical text-books put its melting point at 442° (from Stromeyer). While the New American Cyclopædia, now in course of publication, places it, on the authority of Daniell, at 360° Fahr.

It would be interesting to determine this accurately. But the heat being too high for measurement by the mercurial thermometer, and having no other, I have only been able to judge approximately by comparative tests. Melted under similar conditions with other metals, I find the metal requires for its fusion nearly the same heat as lead. It is somewhat later in melting but on the other hand it appears to congeal a little the sooner, (which may be due to a difference in the conducting power of the two metals.) I should, therefore, place its melting point in round numbers at 600° Fahr., that of lead being placed by different authors, at 594°, 600°, and 612°. It volatilizes at a some-

what higher temperature, giving off orange-colored suffocating fumes, which, when inhaled too freely leave a disagreeable, sweetish, styptic sensation upon the *lips*, and an intolerable and persistent brassy taste in the mouth and fauces, with constriction of the throat, heaviness in the head, and nausea.

Of the general properties of cadmium as an ingredient in alloys, Overman, who I believe is high authority in metallurgy, and who, although too broad in some of his conclusions, is more rigidly exact in respect to the individual instances adduced than others that I have had the opportunity of examining, says:

"Cadmium is very soft and malleable and still all its alloys are brittle. Its combinations are not distinguished for fluidity." Again, "The combinations of platinum, copper, and other metals with cadmium, are brittle and hard." The cause of this he ascribes to "its volatile nature and want of affinity," which, recurring to the subject, he accounts for thus:

"When it is melted with any other metal there is a tendency on its part to evaporate; the slight affinity of cadmium for other metals causes a separation of its atoms from those of the other metal, and no intimate union can be formed. If, therefore, the alloy cools there are spaces between the crystals which have been occupied by the expanded atoms of cadmium, and in cooling, these are filled again; this causes brittleness." *Treatise on Metallurgy*, p. 465.

All this is strictly true of *some* of its combinations, such as the particular instances which he cites, although by no means of "all," as will presently be seen.

Other authors, although less explicit, are to a like import, ascribing a similar, general character to the metal, with examples in illustration, and without instancing any exceptions.

In a copy of Article on Alloys of Cadmium, from *Berthier's Traité des Essais*, Tome 2, p. 530, furnished me by the patent office as authority on the subject, I find it stated in general terms that "most of the alloys of cadmium are brittle;" the individual alloys cited are particularly characterized as brittle, and no mention is made of others.—The combination with mercury is thus described: "Cadmium unites with great facility with mercury, even when cold. The amalgam is of a silver white, and texture granular and crystalline. It can be obtained in octohedrons. It is hard and very fragile. Its density is greater than that of mercury. It fuses at 75° [centigrade.] It contains 0·217 of cadmium."

Combined in these proportions the compound will indeed be comparatively fragile; but one might be led to infer from this description that the metals combine in no other proportions. I have seen this particular form of amalgam cited by other authors when speaking of the combination of cadmium with mercury but without any illusion to other compounds of these metals; although they unite with facility in other proportions, forming amalgams particularly noteworthy as contrasted with those of other metals.

While it has been assumed as a general rule as above quoted, that

the combinations of cadmium are not distinguished for fluidity, I have not found its fluidifying properties in respect to certain metals and alloys noticed in any work to which I have had access. *Some* of its alloys indeed are *not* remarkable for fusibility but, rather for the reverse; such are its alloys with silver, antimony, and mercury, their melting point being but little lower or even higher than that of the mean of their constituents. But others are much more fusible than the mean, as its alloys with lead, tin, copper, bismuth, zinc. In certain instances it manifests this property in so eminent a degree that it is singular it should not, if known, have been explicitly stated in all professed descriptions of the metal. Bismuth holds a high rank among metals for its property of promoting fusibility in alloys, as is particularly remarked in all chemical text-books, and wherever the metal is treated of, its alloys with lead and tin being specially noted as extraordinary instances. But in some combinations cadmium displays this property more decidedly than even bismuth. The alloy composed of from one to two parts of cadmium, two parts of lead, and four parts of tin is more fusible than the corresponding alloy of two parts (or less) of *bismuth*, two of lead and four of tin. In smaller proportions its superiority is still more marked, requiring much less to produce the same effect, while it does not impair the tenacity and malleability of the alloy but confers hardness and general strength.

As to the brittleness which cadmium is said to communicate when combined with any other metals, the facts are, *some* of its alloys even with malleable metals *are* "brittle." But others are highly tenacious and malleable. Its alloys with gold, platinum, and copper, afford instances of the former. Its combinations with lead, tin, and to a certain extent with silver and mercury, are examples of the latter. An alloy of two parts silver and one of cadmium is perfectly malleable and very hard and strong; with equal parts of each it is also malleable but possesses less tenacity; but when mixed in the proportions of two parts of cadmium and one part of silver, it is brittle. Equal parts of cadmium and mercury form a tough and highly malleable composition; in the proportions of two parts of the latter to one of the former; the amalgam is nearly equal in malleability but possesses less strength. These mixtures are remarkable in view of the fact that most amalgams are exceedingly frail and brittle. A mixture of two or three parts of tin with one part of mercury is so fragile as almost to drop to pieces in handling: the amalgams with lead, bismuth, &c., are similar.

The fusibility of the compounds of cadmium and mercury is nearly that of the mean of their constituents, as indeed, appears to be the case with other amalgams. I do not perceive that mercury acts as a fluidifying agent in alloys—it does not strictly promote fusibility but serves merely to communicate of its own fluidity to the compounds in nearly the ratio in which it is employed; it does not, like cadmium, bismuth, &c., confer any new property in this respect. Being fluid at 39° below the zero of Fahrenheit's scale it will of course if it only retain its own property, reduce the melting point of the compounds into which it enters as an ingredient, below that of the metals with which it is united.

Most of the mixtures of mercury with other metals, although it may form certain definite compounds with them, indicate combination by simple solution and mechanical admixture rather than by chemical affinity. With cadmium, however, it exhibits a marked affinity, forming amalgams, or as they might be appropriately designated, *alloys* which possess distinctive characters, indicating a true chemical combination.

But I leave these speculations to professed chemists, hoping the points herein referred to may serve to incite attention to a subject which I think will repay investigation.

Nashville, June 14, 1860.

Specific Gravity of Spirits of Wine.

A Mr. Von Baumhauer has been led by three series of carefully conducted experiments to the conclusion that the densities usually adopted for the mixtures of alcohol and water, from the experiments of Gay-Lussac and others, are incorrect. By his report, it would seem that every precaution was taken to ensure the purity of the materials and accuracy in the results, and the following are his results as compared with those given by Pouillet. The standard of density is water at its maximum density, and the mixtures were made with absolute alcohol. The temperature was 15° Cent. (59° F.)

Per cent. of alcohol, by volume, in the mixture.	Pouillet.	Density. Experiment	
		First Series.	Second Series.
100	0·7940	0·7939	0·7940
95	·8161	·8119	·8121
90	·8339	·8283	·8283
85	·8495	·8438	·8432
80	·8638	·8576	·8572
75	·8772	·8708	·8708
70	·8899	·8837	·8838
65	·9019	·8959	·8963
60	·9133	·9079	·9081
55	·9240	·9193	·9196
50	·9340	·9301	·9302
45	·9432	·9394	·9400
40	·9515	·9485	·9491
35	·9587	·9567	·9569
30	·9648	·9635	·9636
25		·9692	·9696
20		·9746	·9747
15		·9799	·9800
10		·9855	·9855
5		·9919	·9918
0	·9991	·9991	·9991

Acad. des Sciences, Paris.

Preservation of Yeast.

M. de Changy states that by intimately mixing with any ferment, liquid or solid, a certain quantity of animal or vegetable charcoal, and drying the mixture either in a current of air or by rotation, a powder

is obtained which preserves all its fermentable properties for an unlimited time. Beer yeast treated in this way keeps its power for a long time, and the presence of the charcoal in the vat presents more advantages than objections.—*Cosmos.*

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*On the Production of Ozone by means of a Platinum Wire made Incandescent by an Electric Current.** By M. Le Roux.

If a platinum wire, not too large, be made incandescent by an electric current in such a manner that the ascending flow of hot air which has surrounded the wire comes in direct contact with the nostrils, an odor of ozone is perceived. The experiment may be made in the following manner:—A very fine platinum wire ($\frac{1}{10}$th to $\frac{1}{25}$th of a millimetre), 20 centimetres long, is taken; it is formed in any shape, and supported in an almost horizontal position in any suitable manner. A glass funnel of 2 or 3 litres is placed over this, so that the air has sufficient access to the wire. As the neck of the funnel is usually too narrow, it is cut so as to leave an aperture 2 or 3 centimetres in diameter, on which is adjusted a glass chimney of a suitable length; the object of which is to cool the gases heated by the wire. The wire is then made incandescent by means of twelve or fifteen Bunsen's cells. The gas issuing from the chimney is found to have the odor of ozone; iodized starch-papers are altered in a few minutes when placed over the chimney. In this case, the air passing over the incandescent wire undergoes a peculiar modification by which it acquires the properties of ozone; but whether this is effected by the electricity acting as a source of heat, or by its own proper action, must be reserved for further experiments.—*Comptes Rendus*, April 2, 1860.

* From the Lond., Edin., and Dub. Philosophical Mag., May, 1860.

Printing Fabrics in Imitation of Embroidery.†

M. Perrot has recently discovered a novel mode of ornamenting fabrics by the printing process, so as to produce an effect similar to embroidery. This process consists simply in printing, by the aid of rollers, any desired pattern upon a fabric, in a solution of gutta percha, previously bleached by the aid of chlorine, and dissolved by any of the well-known solvents. The fabric so printed is then passed through a box or casing containing woolen, cotton, silk, or other fine flock or colored powder, which adheres only to those parts impressed with the solution, and forms beautifully raised patterns and devices having a fine, soft, and velvety surface. This process recalls to our mind a very similar system which was patented as far back as 1850, by Mr. Auchterlonie, of Glasgow. Our readers will find a notice of Mr. Auchterlonie's system in our 3d vol., 1st series, at page 105, where they will be enabled to compare the two, and judge of their relative values. We have not seen any fabrics ornamented after M. Perrot's plan, but

† From the Lond. Practical Mechanic's Journal, May, 1860.

we inspected Mr. Auchterlonie's fabrics, and witnessed the process of ornamenting, and can speak with the greatest confidence of the success of the system.

New and Cheap Motors.

One of the March numbers of the *Cosmos* contains an enthusiastic editorial describing two new machines which are to revolutionize mechanics in France (when the use of the word becomes legal). We copy the substance of these as a specimen of the statements of men who profess the greatest horror of American exaggerations. The first is a steam-generator somewhat on the Perkins principle of generating steam by the injection of small quantities of water upon red hot surfaces. As so many persons, and among others so many Frenchmen, have done this before, all that the Abbè claims for his friend M. Testud de Beauregard, is the tinning the inside and outside of the boiler, and immersing it in a bath of melted tin; but these novelties, according to account, produce the following desirable results:—(we translate literally)—"Enormous reduction of bulk of the boiler; enormous diminution of the vaporizing surface; absolute impossibility of explosion; immense diminution in quantity of the feed-water; feed of distilled water from the condensation; no more calcareous scale; no more cleaning, or a simple cleaning with a brush; no more slowness in the boiling; no more waste of time; steam entirely dry without any water carried over; steam whose fixed temperature may be changed at pleasure from 200° to 1000°; useful employment of the exhausted steam (*vapeur morte*) for the generation of a new motive force; condensation as perfect as it can be with the production of a vacuum which adds the atmospheric pressure to that of the steam; a truly extraordinary regularity and stability of working; possibility of doubling, tripling, quadrupling, &c., the force obtained at any moment without any danger; a furnace naturally smoke-consuming whatever combustible is employed; the attending to the boiler made much less laborious; these are the incontestible advantages which the tin-bath generator realizes. It is adapted without any increased expense, without any necessity for troublesome or expensive alterations, to all steam engines; its constructors guarantee an economy of 50 per cent. on the fuel before used by them, however reduced this expense may have before been." Now if a handbill issued by a patentee in America had affirmed one-fourth the amount of utter absurdity contained in this extract from a journal which we regard as the very best scientific journal in France, how long would it be before the editors in France and England had ceased to denounce American extravagance and credulity?

But this, it appears, is no very great thing after all; a better machine is an explosion engine of M. Lenoir. This is described as a "conical cylinder (*cylindre conique*. The Abbè Moigne plumes himself on his mathematics) with an anterior and posterior compartment separated by a piston similar to those of a steam engine." The gas mixed at the rate of 5

per ct. with 95 of air, is admitted successively at each end and exploded by a spark from a small induction machine; thus blowing the piston back and forward. All this is well enough and old enough, but look at the results:—"With 5 per cent. of gas and 95 of air, the shaft and fly-wheel made 120 turns; the force produced was fully that of a horse power. A stout man operating on the circumference of the fly-wheel could not stop it; a mass of iron on the shaft was cut by the gouge or chisel without trouble. With this speed of 120 turns for twelve hours, the expenditure of gas is three cubic metres (106 cubic feet). Estimating the cubic metre at 6 centimes (1⅕ cents) the expense per horse power per hour would be a centime and a half, that is about one-half that of the same force from coal.

It will be seen that gas is cheaper in Paris than here, but what is that to what follows. "We applaud with great pleasure the marvellous use which M. Isoard has made of superheated steam united with coal tar, to generate at an excessively low price, and as rapidly as is wished, torrents of very rich lighting gas. If we are not mistaken, the new gas will cost less than a centime per metre cube (56½ cents per thousand cubic feet), and as it requires only three cubic metres for a horse power for 12 hours; this force which in the most privileged countries, *in the county of Cornwall, near the mouth of the mines*, (when did the English coal mines get into Cornwall?) still costs five centimes (1 cent) will cost at Paris but one-fourth of this."

By the way, is not this the Saunders' Patent which has just exploded here, after a temporary notoriety obtained by means similar in character to these, but of less brilliancy?

In the same journal we find the following appreciation of the modification of Rhumkorff's Induction Apparatus by Ritchie, of Boston:

"An American physicist had brought to Paris an induction machine of a form somewhat differing from that adopted by M. Rhumkorff, and of larger dimensions, which, when excited by a sufficient battery, gave a continued series of sparks truly frightful, 13 inches long and more, and snapping with a formidable noise, less like electric discharges than like thunder-bolts. The professors and physicists who saw it in operation at M. Jules Duboscq's were astonished; it threw the apparatus of the celebrated artist into the shade, and for a moment it might be believed that they had been surpassed. M. Jamin, the Professor at the Polytechnic school, who was anxious to enrich the collections of that establishment with an extraordinary induction machine, gave a sort of challenge to M. Rhumkorff; he threatened to purchase the American machine, if within a very short interval he did not produce as powerful a one. M. Rhumkorff accepted the challenge, and his new apparatus, which costs less than half that of the American, is still more powerful; the sight of his sparks, or of his thunder-bolts, causes the boldest to tremble; with 6 couples of Bunsen, the sparks extend to the enormous distance of 16½ inches."

Now, omitting this extravagance about the thunder-bolts and terrors, which is unworthy of a serious writer on Science, let us establish the facts upon which the story is based. Prof. McCulloh, of Columbia

College, N. Y., took out with him one of Mr. Ritchie's instruments. Up to this time M. Rhumkorff had never got a spark over 3 inches in length; nor had Mr. Hearder, who improved Rhumkorff's instrument in England, got over 6. Mr. Ritchie's instrument is operated by 3 cells of a Bunsen battery, and the largest form (which we believe to be the one taken over by the Professor) is capable of giving sparks 18 inches in length.

M. Rhumkorff had (we believe) 6 months given him to produce his competing machine, and was allowed to examine Mr. Ritchie's instrument and even to dissect it; Mr. Ritchie never having attempted any secrecy as to the differences between the original instrument and what he modestly called a modification, although it is in some respects entitled to be considered a new instrument. If, then, M. Rhumkorff has not done better with 6 cups of battery than Ritchie has done with 3, the Abbè had better reserve his eloquence for future endeavors.

City Telegraph.

J. Herpin proposes to establish throughout Paris a system of telegraphs by which messages may be easily and rapidly sent from one part of the city to another. This would be a great convenience and a great benefit for business men. The proposed tariff is very cheap. For a simple message; by day, 2 cents; by night, from midnight to 6 A. M., 4 cents: message and answer, 3 cents by day, 5 cents by night. He calculates the probable yearly profits of the enterprise at $200,000, besides the employment given to laborers, lame and feeble persons, women, &c.—*Cosmos.*

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*Transparent Ivory.**

The process for making ivory transparent and flexible is simply immersion in liquid phosphoric acid, and the change which it undergoes is owing to a partial neutralization of the basic phosphate of lime of which it principally consists. The ivory is cut in pieces not thicker than the twentieth part of an inch, and placed in phosphoric acid of a specific gravity of 1·131, until it has become transparent, when it is taken from the bath, washed in water, and dried with a clean linen cloth. It becomes dry in the air without the application of heat, and softens again under warm water.—*Druggists' Circular.*

* From the Lond. Chemical News, No. 16.

Self-Registering Hygrometer.

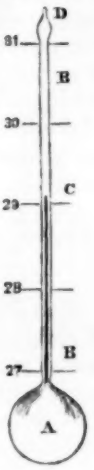
MM. Midre and Chaviere have improved the common hair hygrometer of Saussure by adding to it two loose hands, which are moved by a pin from the main index, so as to register maxima and minima. The improvement is very simple, but none the worse for that.

Cosmos.

*Description of an Hermetically-sealed Barometer.** By RICHARD ADIE, Liverpool.

When mounted on an ivory scale, this instrument resembles in size and portability a pocket thermometer of the medium or larger class.

It is constructed from a piece of thermometer tube, in which, in lieu of the spherical or cylindrical bulb formed for a thermometer, a cistern is made in the form of the section of a cylinder, 1·4 inches diameter and 1-10th of an inch thick, varying these measures according to circumstances; but generally the bulb has nearly the shape and dimensions of a half-crown. On the top of the tube there is an air cavity similar to that used in Dr. Rutherford's registering thermometer.



A. The cistern containing alcohol.
BB. The tube in which the height corresponding to the barometer is read.
C. The top of the alcohol column.
D. The air-cavity for correcting for temperature.
31 to 27. The figures to represent the height of the column C, with reference to the mercurial column.
Sub-divisions between each inch are added so as to read off to ·02.

The influence of change of temperature is got rid of by trial and adjustment of each instrument; so that the expansion of the air in the upper cavity will counterbalance the expansion of the liquid in the cistern. This correction for temperature applies only to the condition of equal heating of the instrument throughout. When it is well done, an instrument is obtained, which is extremely sensitive to any change of atmospherical pressure.

If dipped in water at the temperature of the air, the column in the tube immediately rises to show the increase of pressure. When carried from one story of a house to another, the change is noticed as the stairs are ascended. In the beginning of last April, I put one of the barometers in the corner of the compartment of the railway carriage in which I was traveling, from Liverpool to Edinburgh, where it indicated regularly the extensive changes from the sea level which that line of route contains.

The hermetically-sealed barometer which I have found to work best, is filled with colored alcohol; the column in the tube moving through about 1·5 inches for every inch of the mercurial barometer.

Filled with mercury, instruments corrected for temperature were obtained to move through half an inch for every inch of the barometer; but, in point of mobility, they were much inferior to alcohol-filled tubes.

Filled with ether, an instrument corrected for temperature could not be obtained in combination with delicacy of indication; but if the

* From the Lond. Quar. Jour. of the Chemical Society, April, 1860.

correction for temperature be dispensed with, and a place can be found for the barometer where the changes of temperature are small, ether, in an hermetically-sealed tube of the kind described, would furnish a most minute measure of changes in atmospheric pressure.

A tube filled with water did not act with delicacy, from the want of mobility in the fluid.

In the hermetically-sealed barometer, the reading may be much disturbed by unequal heating, when the instrument is held in the hand, or the sun allowed to shine on a portion of it. This can in a degree be prevented by the skill of the observer, with the interposition of non-conductors, and when carried by holding the instrument suspended by a cord, rather than keeping it in the pocket or hand. When the indication has been disturbed by unequal heating, it must remain suspended fifteen or twenty minutes before a reliable reading can be made.

Thin Cast Iron. By WM. FAIRBAIRN, Esq., F. R. S., &c., President, in the Chair.

From the Lond. Chemical News, No. 19.

The President exhibited two large pans of cast iron, procured by Mr. Worthington from China, where they are used for boiling rice. The metal, which is at the strongest part only one-tenth of an inch in thickness, possessed considerable malleability. The President remarked that the art of making such large castings of thin metal, was unknown in England.—*Proc. Manchester Lit. and Philo. Soc.*

Electro Copies of Engraved Steel Plates. By HENRY BRADBURY.

From the Journal of the Society of Arts, No. 389.

SIR:—Through the medium of the *Journal of the Society of Arts*, in July last, I made known the result of my endeavors to deposit pure nickel upon the surface of engraved copper plates. This I have continued to do with marked success. The deposit has nearly the appearance of silver in color, possesses almost the hardness of iron, is free from oxidation by air, resists the action of the ordinary acids, and, being easy of manipulation and inexpensive, is well worthy of attention. Each coating will furnish 5000 impressions and upwards. It is so hard as to stand the free use of the burnisher, and its texture is so fine as not to show the worn away portions of the deposit after each successive coating.

Finding the deposit so beautifully fine in texture and polished in surface, it occurred to me that if an engraved steel plate were covered with such a deposit, the plate might safely be immersed in a solution of sulphate of copper, and a metallic matrix be produced direct from it, without the risk of injury from the action of the acid of the solution. I have tried this with complete success, and have found (as might be supposed) that an electro copy of a steel plate thus obtained is very superior to one made from a matrix of gutta percha or other plastic composition. The engraved plate, however, must be quite free from under-cut lines.

12 and 13 Fetter Lane, Fleet Street, May 2, 1860.

Fusion of Platinum.

M. H. Sainte-Claire Deville continues to announce his fusion of platinum as though there were something new in it. In this city it has been worked in this way in large masses for years, by Mr. Bishop, formerly assistant to Dr. Hare. And, by the way, as Prof. Deville continues to find the density of iridium 18, it is evident that his fusion of that metal must be very imperfect, for Drs. Hare and Boyè found 21·8, and the latter was not free from air-bubbles. Iridium is, therefore, the heaviest metal yet known.

Clarifying Coal Oils.

From the Lond. Chemical News, No. 16.

Messrs. Dumoulin and Cotelle have been making a series of experiments with a view of rendering heavy oils suitable for ordinary lighting purposes, and have succeeded in producing a magnificent light, free from smoke and smell, and adapted in all respects for burning in a room. The following is their process:—In a close vessel are placed 100 lbs. of crude coal oil, 25 quarts of water, 1 lb. of chloride of lime, 1 lb. of soda, and half a pound of oxide of manganese. The mixture is violently agitated and allowed to rest for 24 hours, when the clear oil is decanted and distilled. The 100 lbs. of coal oil are to be mixed with 25 lbs. of resin oil; this is one of the principal points in the manipulation: it removes the gummy parts from the oil and renders them inodorous. The distillation spoken of may terminate the process, or the oils may be distilled before they are defecated and precipitated.—*Le Génie Industriel.*

On the Composition of Water obtained from the Coal-strata, Bradford Moor, Yorkshire. By F. A. Abel, Esq.

From the Lond. Ed. and Dub. Phil. Mag., May, 1860.

The analysis of a sample of water from the above source was undertaken a short time since with the view to ascertain whether it was adapted to general domestic purposes. The results furnished by the examination appeared of sufficient interest to warrant their publication.

Two samples of the water collected at the mouth of a coal-pit, at an interval of about one month (the separate analyses of which furnished thoroughly concordant results), were submitted to me officially for examination by Lieutenant-Colonel Hamley, Commanding Royal Engineer at York, who informed me that the water, which is highly esteemed in the neighborhood for drinking and culinary purposes, is raised from coal-pits, at a depth of about 200 feet beneath Bradford Moor—an abundant and regular supply being obtained.

The specific gravity of the water was 1000·78 at 60° F. Its reaction was powerfully alkaline, and its flavor was brisk and agreeable.

The proportion of solid matter obtained on evaporation amounted to 44·1 grains in an imperial gallon, of which by far the largest proportion consisted of carbonate of soda.

The alkalinity of the boiled water was determined by means of standard sulphuric acid, and found to be equivalent to a proportion of 30·76 grains of carbonate of soda in an imperial gallon.

The result obtained by the direct determination of the carbonic acid, corresponded accurately to the proportion required by theory to hold in solution the whole of the lime and magnesia in the water, and to form bicarbonate with the amount of soda represented by the number above quoted.

The following statement represents the proportions of the various constituents existing in solution in an imperial gallon of the water:—

Bicarbonate of soda,	43·53
Sulphate of soda,	7·50
Chloride of sodium,	1·34
Sulphate of potassa,	0·31
Phosphate of lime,	trace.
Carbonate of lime,	1·90
Carbonate of magnesia,	0·80
Organic matter,	1·20

Carbonic acid, holding the carbonates of lime and magnesia in solution, 1·25 grain = 2·642 cubic inches at 60° F.

The absence of nitric acid, ammonia, silicic acid, alkaline sulphides, and oxide of iron was established by special examinations.

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*A Composition named Zeiodelite, a kind of Paste which becomes as hard as Stone, is unchangeable by the Air, and being proof against the action of Acids, may replace Lead and other substances for various uses.** JOSEPH SIMON, 1859.

Zeiodelite is made by mixing together 19 lbs. of sulphur and 42 lbs. of pulverized stoneware and glass. The mixture is exposed to a gentle heat, which melts the sulphur, and then the mass is stirred until it becomes thoroughly homogeneous, when it is run into suitable moulds and allowed to cool. This preparation is proof against acids in general, whatever their degree of concentration, and will last an indefinite time. It melts at about 120° Centigrade, and may be re-employed without loss of any of its qualities, whenever it is desirable to change the form of an apparatus, by melting at a gentle heat and operating as with asphalte. At 110° Centigrade it becomes as hard as stone, and therefore preserves its solidity in boiling water. Slabs of zeiodelite may be joined by introducing between them some of the paste heated to 200° Centigrade, which will melt the edges of the slabs, and when the whole becomes cold it will present one uniform piece. Chambers lined with zeiodelite in place of lead, the inventor says, will enable manufacturers to produce acids free from nitrate and sulphate of lead. The cost will be only one-fifth the price of lead. The compound is also said to be superior to hydraulic lime for uniting stone, and resisting the action of water.

* From the Lond. Chemical News, No. 14.

For the Journal of the Franklin Institute.

Particulars of the Steamer Kilauea.

Hull built by Paul Curtis. Machinery by Atlantic Works, Boston, Mass. Owners, C. A. Williams & Co. Intended service, at the Sandwich Islands.

HULL.—Length on deck, 130 ft. 8 ins. Breadth of beam (molded), 26 ft. Depth of hold, 10 ft. Do. to spar deck, 16 ft. 6 ins. Frames—molded, 13 ins.—sided, 12 to 14 ins.—apart from centres, 30 ins., and strapped with diagonal double braces, $3\frac{1}{2} \times \frac{3}{4}$ in. Draft, forward and aft, 10 ft. Tonnage, 398 tons. Area of immersed section at load draft of 10 ft, 225 sq. ft. Masts, two—Rig, Brigantine.

ENGINES.—Vertical direct-acting. Diameter of cylinder, two of 26 ins. Length of stroke, 3 ft. Maximum pressure of steam, 25 lbs. Cut-off, ordinarily one-fourth. Maximum revolutions at above pressure, 55.

BOILER.—One—Return flue. Length, 28 ft. Breadth, 7 ft. 9 ins. Height, exclusive of steam chimney, 8 ft. 9 ins. Number of furnaces, two. Breadth do., 3 ft. 4 ins. Length of grate bars, 6 ft. 3 ins. Number of flues, above, 4, below, 10. Internal diameter do., above, 1 ft. 6 ins., below, 8 of 10 ins. and 10 of 18 ins. Length do., above, 22 ft. 8 ins., below, 15 ft. 11 ins. Diameter of smoke pipe, 3 ft. 3 ins.

PROPELLERS.—Diameter of screw, 9 ft. Length do., 3 ft. 6 ins. Pitch do., 21 to 23 ft. Number of blades, three.

C. H. H.

Specification of a Patent granted to Barnabas Wood, of Davidson County, State of Tennessee, for an Improved Alloy or Metallic Composition suitable for a Metallic Cement in the manufacture of Tin, Pewter, and other metals; also useful for casting and other purposes.—Dated March 20th, 1860.

The object of my invention being to produce an alloy possessing great fusibility in connexion with the requisite tenacity and malleability suited for certain uses; I effect this object by the employment of cadmium in suitable proportions in combination with certain proportions of lead and tin: by which means I have produced an alloy which is superior to others in use in respect to the joint qualities above mentioned, and which, as a metallic cement or solder in fabricating wares from certain metals, is an improvement upon all others. It is claimed as an improvement upon the ordinary solders especially for soldering metals consisting essentially of tin, such as pewter and other of the more fusible combinations of tin employed in the arts; and in general in all those cases which require an easily melted, and highly tenacious and malleable solder.

It consists of the following proportions, which may be somewhat modified in various ways without substantially modifying the result, to wit:

Cadmium from one to two parts; lead two parts; tin four parts; the result as to fusibility and tenacity being nearly identical whether the cadmium be used in the larger or smaller ratio.

This alloy possesses great strength and tenacity, is perfectly malleable, and melts at a temperature somewhat under 300° F., being

some 50° or 60° below the melting point of the most fusible mixture of lead and tin used for solder; and is not inferior in other qualities. And in the essentials of tenacity and malleability it is superior to any of the so-called "bismuth solders" which melt at as low a temperature. Its qualities render it likewise superior to any other alloy for casting and modeling purposes, in certain cases, as will be at once evident to those versed in the business.

The specimen marked "No. 3" forwarded Oct. 31st, 1859, consists of one part cadmium, one part lead, and two and a half parts tin. Of the additional specimens, No. 4 contains two parts cadmium, two lead, and four tin; and No. 5, one part cadmium, two parts lead, and four tin.

For greater fusibility to suit particular cases, mercury may be added, although its tendency is, especially if used in large proportion, to impair the quality of tenacity, according as it improves that of fusibility. But it may be used in quantity at least equal to that of the cadmium without sensible detriment, while three or even four times that amount will not so destroy the useful qualities of the composition but that it may be used to advantage as a solder for certain cases, thereby lowering its melting point to nearly the temperature at which water boils.

The greatest fusibility is obtained when cadmium is used in the proportions of the formula above named, or in the ratio of one-fourth to one-eighth of the joint quantity of lead and tin; but I do not confine myself to this ratio, as the cadmium, for economy, may be considerably reduced, say to one-tenth or one-twelfth of the other two metals, without materially diminishing this quality of the alloy for practical use.

Cadmium may be used upon the same principle to improve the ordinary tinner's solder also called "fine solders," consisting essentially of tin alloyed with lead in the proportion of about one part lead to two or three parts tin; being used in the ratio aforesaid in respect to the sum of these metals, thereby conferring greater fusibility than a like ratio of bismuth, without, like bismuth, impairing the qualities of tenacity and malleability.

The same holds in respect to the combinations of lead, tin, and bismuth, or "bismuth solders" in the more fusible forms of which, the use of cadmium, according to the same principle, will produce results not hitherto obtained, and of decided benefit.

In particular, those mixtures of lead, tin, and bismuth which melt at, or somewhat under, the temperature of boiling water, and which in consequence of this extreme fluidity are known by the common name of "fusible metal," may, by the means indicated, be greatly improved in this quality without detriment to other useful qualities—the use of cadmium in any form in these mixtures to an amount equal to one-fourth, or one-eighth of the amount of lead and tin in them producing about the greatest attainable fusibility; although to insure the best results in respect to other qualities, as tenacity and pliability, it is better to use a little more lead and less tin than stated in the usual formulas of "fusible metal." I generally use the following proportions where the greatest fusibility is required, to wit:—cadmium one to two parts, tin two parts, lead four parts, bismuth seven to eight parts; the alloy

in these proportions melting at about 160° F., being some 40° or 50° below the melting point of the said "fusible metal" and not inferior in other qualities for the purpose of a metallic cement. The specimen marked "No. 1", contains the larger proportion of cadmium, consisting of cadmium 56 parts, tin 59 parts, lead 103½ parts, bismuth 212 parts, being combined according to the chemical equivalents of the ingredients, conceiving the union to be more intimate and perfect—although subsequent experiment has not demonstrated any practical advantage to result from such nice adjustment of proportions.

When the cadmium constitutes from one-tenth to one-twelfth of the joint amount of lead and tin, the melting point will be about 170° or 180° F., being low enough for general use in most cases.

These proportions may be somewhat varied without materially modifying the result. The proportions of cadmium and bismuth remaining the same, those of the lead and tin may be greatly varied in respect to each other, provided they jointly hold a similar ratio to the whole. Thus for greater softness the lead may be employed in a much greater excess over the tin than stated in the formula, and for greater hardness and rigidity, the tin may preponderate over the lead.

This alloy may be used as a cement for very fusible alloys, such as the "white metal" used for bells, the *cliché* of the French, and the so-called "fusible metal" above named; also for light wares of pewter, &c., and as a convenient temporary cement; also for light castings requiring a more fusible material than the bismuth alloys; not being liable to the objections appertaining to the amalgams resorted to in such cases.

Its melting point may be lowered by adding mercury, which, in quantity equal to one or two parts of the cadmium, is less objectionable than in alloys without cadmium.

For greater tenacity with a melting point similar to that of the "fusible metal" before mentioned, a larger proportion of lead should be used, so that this metal shall equal or somewhat exceed the quantity of bismuth.

My mode of compounding the ingredients possesses nothing peculiar; they may be melted all together and mixed by stirring, or melted separately and poured together. I usually melt the cadmium and lead together in one vessel, and the tin, or tin and bismuth, in another, pouring them together when melted, and mixing thoroughly by pouring the whole a few times from vessel to vessel. Mercury when used is added to the melted alloy, mixing as before.

Nor is my manner of using the composition peculiar. The parts of the metals to be cemented are touched with a solution of chloride of zinc, and the solder applied as usual, and fused by the application of heat in any of the ordinary modes. In casting, when used for taking casts or moulds from other fusible metals, these should be brushed over with black lead, lamp black, India ink, or other pigment, to prevent adhesion. A solution of logwood or red sanders in alcohol is very convenient for the purpose.

I do not claim the combination of lead and tin, or of lead, tin, and

bismuth, in the proportions specified, nor any other, separate and apart from cadmium. Nor do I claim any results that have been produced by any of the combinations referred to apart from cadmium, whether that of fusibility or any other, nor any merely equivalent results that may have been hitherto produced by other combinations. I do not claim the use of cadmium as an alloy, or as an ingredient in alloys, to be any thing new, nor its use in connexion with any of the metals specified for the purpose of producing any results in alloys other than those described. I confine myself to its use in the ratio substantially as specified in combination with the metals herein specified in the proportions of the said metals substantially as set forth, so as to produce an improvement in alloys whether in the qualities of fusibility and tenacity jointly, or of either (separately), but without practical detriment to the other, so as to produce a better article for use as a metallic cement, and for certain other uses.

What I therefore claim as my invention is,

The composition of matter, or alloy, consisting of the following proportions of cadmium, lead, and tin, or any modification thereof substantially as indicated so as to produce a similar result in alloys, to wit: cadmium from one to two parts, lead two parts, tin four parts, possessing the properties and advantages as herein described, and that may be used as a metallic cement, and for other purposes, and to which also mercury may be added, as set forth, to modify the result for particular cases.

I also claim as a further application of the same principle embodied in the production of the aforesaid alloy, the composition of matter or alloy consisting of from one to two parts cadmium, two parts tin, four parts lead, and seven or eight parts bismuth, or any modification thereof as herein specified and indicated so as to produce an alloy as described, useful as a cement and for other purposes as set forth, and to which also mercury may be added as stated.

What I claim as new in either case being the herein specified improvement in alloys produced by using cadmium in the ratio and manner herein described, in combination with the metals specified in the proportions thereof substantially as set forth.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM MAY 1, TO MAY 31, 1860.

Air Engine,—Compressed	Dana Bickford,	Westerly,	R. I.	15
Amalgamator,	J. A. Brock,	Chicago,	Ill.	1
Auger,—Hollow	Nye and Haviland,	Elmira,	N. Y.	22
Axle Boxes,	H. L. Castile,	Memphis,	Tenn.	15
———,—Making	A. E. Smith,	Brouxville,	N. Y.	8
Ballot-box,	G. L. Bailey,	Portland,	Me.	22
Bands for Machinery,	J. H. Clifton,	Newcastle,	Penna.	22
Bark Mills,	William Tansley,	Salisbury Cent.	N. Y.	29
Barometers,	H. A. Clum,	Auburn,	"	29
Barrels,—Tools for Opening	David Snedeker,	City of	"	8

Basket, .	J. K. Park, .	Marlboro',	Mass.	1
Bayonet Scabbards,—Manuf. of	Emerson Gaylord,	Chicopee,	"	15
———————,—Frog for	William Hoffman, .	Solano co.,	Cal.	8
Bed Bottom, .	L. W. Buxton, .	Nashua,	N. H.	8
Bedstead Fastening,	Richard Hubbard, .	Milton,	Ind.	15
——————— .	Purches Miles, .	New Haven,	Conn.	15
———,—Folding	Edward Cotty, .	Brooklyn,	N. Y.	1
Bedsteads,—Invalid .	A. W. Chase, .	Ann Harbor,	Mich.	15
Bee-hives, .	J. S. Black, .	Bloomfield,	Ky.	15
Beer Powders, .	John McKellar, .	Thomaston,	Me.	15
Bill of Fare, .	William A. Bury,	Grosse Isle,	Mich.	8
Billiard Table Pocket-irons,	J. P. Ellicott, .	Washington,	D. C.	1
——— Tables,—Chalk-holder	" .	"	"	22
Boats,—Suspending .	C. H. Hasker, .	Portsmouth,	Va.	29
Bolt,—Flush .	William R. Carnes,	Roxbury,	Mass.	22
Bonnet Frames,—Clamp for	H. A. Reynolds, .	City of	N. Y.	1
Bonnets, .	A. Henri, .	Louisville,	Ky.	1
Book-binding, .	Thomas Towndrow, .	City of	N. Y.	29
Boot and Shoe Soles,—Burnish.	E. T. Ingalls, .	Haverhill,	Mass.	8
——————,—Fill'g for	E. N. Foote, .	Saratoga Spr's,	N. Y.	1
Boots & Shoes,—Jointed Tip for	G. A. Mitchell, .	Turner,	Me.	22
——————,—Skiv. Counters	W. A. Bacon, .	Campello,	Mass.	29
——————,—Wooden Soles	Alexander Hanvey,	Steubenville,	Ohio,	1
Bosom Expanders, .	Church and Ellsworth,	Birmingham,	Conn.	8
Brushes, .	William Tusch,	Brooklyn,	N. Y.	22
Brush,—Hair .	J. R. Ingersoll, .	City of	"	22
Buildings,—Machine for Moving	Samuel Wells, .	Elmore,	Ohio,	22
Butt Hinge, .	J. E. Shields, .	Washington,	D. C.	29
Butter,—Machine for Printing	Miller and Wiegand,	Philadelphia,	Penna.	22
——— Worker, .	Lydia W. Stiles, .	Brooklyn,	Ohio,	15
Camp Stool, .	J. W. Willett, .	Wareham,	Mass.	22
Canal Locks,—Gates for	S. J. Seely, .	Albany,	N. Y.	8
Cane Juice,—Defecating	E. H. Wheeler, .	New Orleans,	La.	8
Canals,—Auto. Draw-bridges for	G. C. Bovey, .	Chillicothe,	Ohio,	8
Candle Mould Boxes, .	G. A. Stanley, .	Cleveland,	Ohio,	8
——— Moulding Apparatus,	" .	"	"	8
Cane Juice,—Clarifying	P. Marcelin & E. Eude,	New Orleans,	La.	22
Caoutchouc,—Vulcanizing	S. W. Warren, .	City of	N. Y.	22
Caps,—Forming Seamless Felt	J L Bridge & W B Lodge,	Vernon,	"	8
——,—Making Sheet Metal	Orrin Newton, .	Pittsburgh,	Penna.	22
Car Brakes, .	H. A. Mears, .	Pecatonica,	Ill.	1
——— .	E. F. Jewett, .	Plainville,	Ohio,	1
—— Couplings, .	J. S. Vaughan, .	Alexandria,	Va.	22
—— Seats, .	C. A. McEvoy, .	Richmond,	Va.	8
—— Springs, .	William Kingsbury,	City of	N. Y.	8
—— Wheels, .	S. P. Smith, .	Troy,	"	29
—— Windows,—Sash-support,	H. K. Smith, .	Philadelphia,	Penna.	29
Cars for Transport'g Cattle, &c.,	Lee Swearingen, .	Valley Riv. F's,	Va.	29
Carpet-cleaner, .	H. L. Nichols, .	City of	N. Y.	22
Cattle,—Apparatus for Breachy	J. P. Ledy & W. Boyers,	Mt. Carroll,	Ill.	15
Cement, .	Horace Billings,	Beasdstown,	"	1
——— .	Charles Fricke, .	Mobile,	Ala.	1
——— .	" .	"	"	29
Cements,—Silicated	G. E. Vanderburgh,	Mamaraneck,	N. Y.	29
Chimney Cowl, .	George Millard, .	Waterbury,	Conn.	15
Churn, .	W. B. Gordinier,	Coudersport,	Penna.	8
——— .	R. G. Holmes, .	Worcester,	Mass.	8
——— .	G. H. Van Vleck,	Buffalo,	N. Y.	8
——— .	J. W. Evans, .	Forsyth,	Ga.	29
——— .	D. M. Woodin, .	Brandon,	Wis.	29
Cigars,—Machines for Making	Thomas Thorp, .	City of	N. Y.	1
Clocks Vertically,—Adjusting	J. F. Keeler, .	Cleveland,	Ohio,	1

Cloth,—Machinery for Drying	Bezaleel Sexton,	Albany,	N. Y.	8
Clothes-frame,	J. Fraser,	Rochester,	"	15
Coffins,	Carter and Jones,	City of	"	29
Coke,—Desulphurizing	George Nock,	Pittsburgh,	Penna.	29
Corn Planters,	William C. Banks,	Como Depot,	Miss.	1
————	"	"	"	1
————	Amos Seaman,	Winnebago co.,	Ill.	1
————	J. H. Bonham,	Elizabethtown,	Ohio,	22
————	A. Hayes & J. Vancuren,	Chenoa,	Ill.	22
————	Joel Lee,	Galesburgh,	"	22
————	B. T. Stowell,	Quincy,	"	22
————	John Johnson,	Naples,	"	29
————	J. C. Moore,	Peoria,	"	29
—— Shellers,	J. G. Putnam,	Tioga,	Penna.	22
Cotton,—Machines for Cleaning	John Gilmore,	New Orleans,	La.	22
——— Bales,—Iron Ties for	Walter Stewart,	Natchez,	Miss.	1
————	Wm. S. Loughborough,	Rochester,	N. Y.	8
————,—Locks for	A. P. Merrill, Jr.,	Natchez,	Miss.	22
————,—Metal Ties for	James Aiken,	"	"	1
——— Presses,	Y. F. Wright,	Green Hill,	Ga.	1
————	M. M. Jones,	Morrisville,	N. Y.	15
——— Seed Planters,	N. E. Badgley,	Gadsden,	Ala.	1
Counter Shaft,—Arrangement of	G. W. Davis,	Brooklyn,	N. Y.	22
Couplings for Shafting,	Samuel Hall,	City of	"	29
Cow-milkers,	L. O. Colvin,	Cincinnatus,	"	22
————	"	"	"	29
Cultivator Teeth,	D. B. Rogers,	Pittsburgh,	Penna.	8
Cultivators,	John Neff, Jr.,	Pultney,	N. Y.	8
————	R. P. Van Horne,	Gratiot,	Ohio,	29
————,—Hand	D. C. Jordan,	Center Port,	N. Y.	22
Cup and Stand,—Metallic	S. J. Ladd,	Providence,	R. I.	8
Curtain Fixture,	J. F. Hall,	Bangor,	Me.	22
Dentists,—Moulds for metal dies,	F. Y. Clark,	Savannah,	Ga.	22
Digging Machines,	A. A. Garver,	Mechanicsb'gh,	Penna.	22
Ditching Machines,	Benedict and Cummings,	W. Springfield,	"	15
————	C. O. West and others,	Martinsville,	Ohio,	15
————	John Masters,	Waukegan,	Ill.	22
Door Fastener,	John Lightfoot,	Cold Spring,	Ky.	8
—— Latch,	R. L. Underhill,	Bath,	N. Y.	22
—— Lock,	Henry Lockwood,	City of	"	1
—— Plate,—Glass	Montague & Townsend,	New Bedford,	Mass.	22
Drain Tiles,—Mode of Laying	H. F. Baker,	Centreville,	Ind.	1
Drains,—Cement	Benjamin Livermore,	Hartford,	Vt.	1
Dress Hook,	J. W. Strange,	Bangor,	Me.	8
Drill,—Hand	J. H. Parker,	Boston,	Mass.	15
————	"	"	"	15
Dumb-bells,	D. F. Savage,	"	"	29
Dumping Wagons,	Tolhurst and Sartwell,	Liverpool,	Ohio,	8
Egg-beater,	Frederick Ashley,	City of	N. Y.	1
Elastic Cloth,—Manufacture of	H. H. Day,	"	"	29
Electrodes,—Insulator for	Engler and Krauss,	Paris,	France,	15
Embroidery Sewing Stand,	Dana Bickford,	Westerly,	R. I.	1
Engraving Rollers,—Mach's for	William Shields,	Manchester,	Engl'd,	15
Evaporating Apparatuses,	Isaac Sherman,	Cleveland,	Ohio,	22
————	T. J. Price,	Industry,	Ill.	15
———— Liquids,	Ernst Constantine,	City of	N. Y.	8
————	George Stevenson,	Zionsville,	Ind.	8
Fat,—Machines for Cutting	J. M. Hunter,	City of	N. Y.	8
Fats into Fatty Acids,—Decom.	R. A. Tilghman,	Philadelphia,	Penna.	15
Feathers,—Renovating	O. J. Pennell,	Williamsport,	"	29
Felloes,—Machines for Bending	Arthur Hemenway,	Cleveland,	Ohio,	1

Felling Trees,	Pomeroy Johnson,	Whitney's Pt.,	N. Y.	15
Ferules,	T. W. Detray,	Montpelier,	Vt.	29
Fertilizers,	Lemuel Stephens,	Philadelphia,	Penna.	8
———,—Mach's for Sowing	R. J. Hill,	Americus,	Ga.	29
Filters,	L. S. Chichester,	City of	N. Y.	29
Filtering Apparatus,	J. H. G. D. Wagner,	Paris,	France,	29
Fire Arms,—Hammer Guards	Benjamin Singleton,	Portsmouth,	Va.	1
———,—Repeating	W. H. Elliott,	Plattsburgh,	N. Y.	29
————	"	"	"	29
———,—Revolving	Savage and North,	Cromwell,	Conn.	15
————	A. J. Gibson,	Worcester,	Mass.	22
Fire-escape,	Frederick Seymour,	Cincinnati,	Ohio,	1
———	Baker and McGill,	City of	N. Y.	22
———	Leonard King,	Bridgeport,	Conn.	22
———	Louis Knocke,	Davenport,	Iowa,	22
———	Albin Warth,	City of	N. Y.	29
———	Henry Powelson,	N. Brunswick,	N. J.	29
Fire-place,	Alfred Carson,	City of	N. Y.	22
Fire-proof,—Rendering Safes	A. K. Eaton,	Brooklyn,	"	29
Flock,—Machinery for Cutting	J. Tilton & E. Riston,	Northfield,	N. H.	15
Flues,—Construction of	R. F. O'Brien,	Boonville,	Mo.	15
Fruit and Vegetable Cutter,	W. H. Trissler,	Lima,	Ind.	22
Furnaces,	R. R. Taylor,	Reading,	Penna.	8
———,—Hot-air	Jacob Stuber,	Utica,	N. Y.	1
———,—Feeding Sawdust to	J. P. Wigal,	Henderson,	Ky.	8
Gasaliers,	J. W. Kerr,	Pittsburgh,	Penna.	22
Gas,—Apparatus for Generating	A. K. Tupper,	Milford,	Mich.	22
—— Burners,	G. W. Thompson,	City of	N. Y.	1
—— Retorts,	Charles Wooster,	"	"	22
———,—Securing Lids	J. R. Thomas,	Williamsburgh,	"	29
Gates,	S. H. Sill,	Geneva,	"	8
Gate Pulley,	David Bedell,	Seneca Falls,	"	8
Girders,—Iron Truss	J. W. Murphy,	Philadelphia,	Penna.	8
Glass,—Grinding & Polishing	Albert Broughton,	City of	N. Y.	29
Governor Valves,	G. H. Timmerman,	St. Louis,	Mo.	1
Grain Binding Machines,	Daniel W. Ayres,	Middleport,	Ill.	22
—— Cleaners,	P. C. Fritz,	Barrytown,	N. Y.	1
————	W. W. Webster,	Foxville,	Va.	1
—— Scales,	Charles Hunter,	Indianapolis,	Ind.	8
—— Separators and Cleaners,	Wm. M. Amall,	Sperryville,	Va.	1
—— Weighing Machines,	Lovett Eames,	Kalamazoo,	Mich.	15
Grate,—Coal	W. T. McMillen,	St. Louis,	Mo.	22
Grinding Surfaces,—Pig Metal	Thaddeus Selleck,	Greenwich,	Conn.	1
Grist Mills,	Charles Badger,	Edgerton,	Wis.	22
Gun Stocks,	C. R. Alsop,	Middletown,	Conn.	22
Hair,—Picking Curled	William Adamson,	Philadelphia,	Penna.	29
Halters,	Lewis Whitehead,	Nunda,	N. Y.	1
Hame Tugs,	Jacobs Hovey,	Bedford,	Mich.	8
Harrows,—Seeding	M. S. Root,	Medina,	Ohio,	22
Harvesters,	S. T. Bruce,	Marshall,	Mo.	1
———	W. A. Kirby,	Buffalo,	N. Y.	15
———	Stoler and Sisson,	Bristol,	Penna.	15
———,—Guard Fingers for	G. W. Slough,	Canton,	Ohio,	8
———,—Raking Attach. for	W. H. Wilson,	Denton,	Md.	8
Harvesting Machines,	J. A. Wagner,	Pultney,	N. Y.	22
Hat Bodies,—Felting,	M. R. Lemman,	Columbus,	Miss.	8
Heating Apparatus,—Steam	L. W. Leeds & C. Vaux,	City of	N. Y.	29
————	G. W. Richardson,	"	"	29
——— Buildings,—Boiler for	C. F. Hitchings,	"	"	15
Hemp Brakes,	John Mills, Jr.,	Quincy,	Ill.	29
Hoisting Machinery,	R. A. Wilder,	Cressona,	Penna.	1
——— Persons,—Machines for	I. H. Hobbs,	Philadelphia,	"	15

Hollow Ware,—Spin'g Metallic	John Grey,	Pittsburgh,	Penna.	1
Hominy Mills,	Heatwole & Mauck,	Harrisonburgh,	Va.	1
Hook Catch for Doors,	C. B. Richards,	Brooklyn,	N. Y.	8
Hooks and Eyes,	D. M. Smith,	Springfield,	Vt.	22
Hoops,—Locks for Metal Bale	C. A. Dubs,	Natchez,	Miss.	8
——,—Machine for Splitting	S. F. Atherton,	Fitchburgh,	Mass.	1
Horse Powers,	Glidden & Starkweather,	Alvaretta,	Wis.	29
—— Shoes,	R. A. Goodenough,	Brooklyn,	N. Y.	29
Horses' Feet,—Cushion for	Loren Hall,	Milford,	Mass.	29
Hose,—Machines for Rubber	T. J. Mayall,	Roxbury,	"	15
——,—Manufacture of Rubber	"	"	"	22
—— Coupling,	S. W. Warren,	Brooklyn,	N. Y.	8
—— Tubing,	H. A. Alden,	Matteawan,	"	8
——,—Rubber	T. J. Mayall,	Roxbury,	Mass.	22
——,—Flexible,	H. A. Alden,	Matteawan,	N. Y.	22
Hydrants, &c.,—Valves for	M. C. Meigs,	Washington,	D. C.	22
Hydraulic Motor,	Wm. Kennish,	London,	Engl'd,	15
—— Presses,	C. W. Flippen,	Laurel Grove,	Va.	8
Ice Cream Freezers,	G. W. Davis,	New Orleans,	La.	22
——	C. W. Packer,	Philadelphia,	Penna.	22
——	G. W. Brown,	City of	N. Y.	29
—— Pitcher,	N. F. Griswold,	Meriden,	Conn.	1
India Rubber Goods,—Finishing	Trotter & Williams,	City of	N. Y.	22
Ink Reservoir for Pens,	R. B. Fitts,	Philadelphia,	Penna.	8
Iron,—Restoring Burnt	G W Morris & W Quann,	"	"	1
Kettle Ears,—Making	Morris Wells,	Brooklyn,	N. Y.	8
Keys,	James Deally,	Louisville,	Ky.	29
——,—Attaching Bows to	E. L. Gaylord,	Terrysville,	Conn.	29
Key-holes,—Guards for	T. G. Harold,	Brooklyn,	N. Y.	29
Knives,—Sharpening Cylind.	J. H. and A. T. Goodell,	City of	"	1
Knitting Machines,	Eli Tiffany,	Thompsonville,	Conn.	1
——	John Chantrell,	Bristol,	"	15
——	W. H. McNary,	Brooklyn,	N. Y.	15
Lamps,	John Stuber,	Utica,	N. Y.	1
——	Octave Saulay,	New Orleans,	La.	8
——,—Vapor,	M. V. B. Buel,	Buffalo,	N. Y.	1
——	T. G. Clayton,	Washington,	D. C.	15
——	I. W. Pettibone,	Norfolk,	Conn.	15
——	J. H. Rollins,	Wapello,	Iowa,	15
——	Albertus Geiger,	Dayton,	Ohio,	29
——	S. W. Lowe,	Philadelphia,	Penna.	29
——	T. S. Ray & A. C. Rand,	Buffalo,	N. Y.	29
——,—Burners for	Emil Trittin,	Philadelphia,	Penna.	15
——,—Generators for	S. D. Baldwin,	Milwaukie,	Wis.	8
Lanterns,	J. D. Brown,	Cincinnati,	Ohio,	29
Laps,—Machinery for Winding	J. E. Cheney,	Lowell,	Mass.	15
Lasting Machines,	W. Wells,	Boston,	"	1
Lathes,	J. M. Scribner,	Middleburgh,	N. Y.	15
Leather,—Machines for Finish'g	W. P. Martin,	Salem,	Mass.	1
——,—— Stretch'g	J. H. Haskell,	Baltimore,	Md.	15
Lifting Jacks,	Wm. Clare Anderson,	St. Louis,	Mo.	15
Locks,	Lyman Derby,	City of	N. Y.	8
Lock,	Andrew Rankin,	Philadelphia,	Penna.	22
Locks for Traveling Bags,	Bourne & Cunningham,	City of	N. Y.	1
Locomotive Boilers,	John Thompson,	East Boston,	Mass.	29
Looms,	Tillotson Clarkson,	South Adams,	"	1
——	J. H. Clifton,	Newcastle,	Penna.	29
——,—Harness Frames for	James Greenhalgh, Sr.,	Pascoag,	R. I.	15
——,—Narrow-ware	Benjamin Hardy,	City of	N. Y.	1
Lozenges,—Machines for Cut'g	W. J. McClelland,	"	"	8
——,—— Mak'g	Gottfried Kober,	"	"	22

Mainsails of fore-and-aft vessels,	G. W. Gerau,	Brooklyn,	N. Y.	22
Marine Charts,—Bearings, &c.,	E. R. Knorr,	Washington,	D. C.	1
—— Propeller,	Eldridge Weber,	Gardiner,	Maine,	29
Measuring Tapes,	O. W. Minard,	Waterbury,	Conn.	1
Meat Chopper,	C. B. Beeker,	Lancaster Co.,	Penna.	8
—— Cutter,	Purches Miles,	New Haven,	Conn.	22
Mechanical Movements,	J. H. Wait,	Portsmouth,	Ohio,	15
Millstones,—Cementing	Samuel Hoyt,	Wilmington,	Del.	1
——,—Dress for	John Broughton,	City of	N. Y.	22
——,—Hanging	J. H. Glover,	Glasgow,	Ky.	22
——	G. P. Dance.	Columbia,	Texas,	29
Mills,—Plates to	Stephen Hull,	Poughkeepsie,	N. Y.	22
Mill Races,—Floating Sluices	M. A. Shepard,	Parkersburgh,	Ill.	8
Moulding,	John Dougherty,	Cold Spring,	N. Y.	15
Mouldings,—Machine for Cut'g	J. B. Winslow,	Charlestown,	Mass.	29
Mop Wringer,	Orville Choate,	Morrisville,	Vt.	15
Motion,—Converting	Louis Planer,	City of	N. Y.	22
Mousing Hook,	S. G. Coleman,	Providence,	R. I.	1
Mowing Machines,	A. M. George,	Nashua,	N. H.	1
Mowing and Reaping Machines,	Richard Ketchum,	S. Dansville,	N. Y.	15
Musical Instrument,	Aloys White,	New Haven,	Conn.	8
—— Instruments,—Reed	George Woods,	Boston,	Mass.	8
—— Reeds,	J. C. Briggs,	Woodbury,	Conn.	1
Nut Cracker,	S. J. Smith,	City of	N. Y.	15
Oils obtained from Coal,	Luther Atwood,	City of	N. Y.	29
——,—Condensing Coal	J. F. Bennett,	Pittsburgh,	Penna.	29
——,—Distilling Coal	H. W. Adams,	Brooklyn,	N. Y.	29
——,—Re-distillation of Coal	Luther Atwood,	City of	"	15
——, &c.,—Furnace for Coal	James Calkin and others,	Hudson,	"	8
Ordnance,—Breech-loading	Wm. W. Hubbell,	Philadelphia,	Penna.	29
——	"	"	"	1
Ores,—Machines for Crushing	Wm. P. Parrott,	Boston,	Mass.	1
Ovens,	Duncan McKensie,	Brooklyn,	N. Y.	1
Ox Shoes,	A. Van Valkenburgh,	Griffin's Corners,	"	8
—Yoke Fastenings,	Wm. N. Lockwood,	New Britain,	Conn.	22
Paint,—Machines for Mixing	Brown & Banker,	Boston,	Mass.	15
Paper,—Preparation of	J. L. Jullion,	Aberdeen,	Gr. Brit.	8
—— Bag Machine,	S. E. Pettee,	Philadelphia,	Penna.	29
——	G. F. Lufbery,	City of	N. Y.	8
—— File,	Elisha Clark.	"	"	8
——	Adolphus Liebenroth,	"	"	22
——,—Safety	M. A. Howell, Jr.,	Ottawa,	Ill.	22
—— Stuff,—Boilers for	C. S. Buchanan,	Ballston Spa,	N. Y.	1
Peach Parer,	Marvin Smith,	New Haven,	Conn.	15
Pegging-machine Jack,	Walter Fitzgerald,	Boston,	Mass.	22
Pessaries,	J. M. Heard,	Aberdeen,	Miss.	29
Piano-fortes,	J. A. Gray,	Albany,	N. Y.	1
Piano-forte Action,	Wm. Compton,	City of	"	22
——	G. H. Hulskamp,	Troy,	"	22
Pictures,—Mouldings for Hang'g	Henry Hochstrasser,	Philadelphia,	Penna.	8
Pile Fabrics,—Manufacture of	Noble Hill,	Caton,	N. Y.	29
Pipes,—Molds for Cement	Henry Knight,	Jersey City,	N. J.	8
——,—Moulding Iron	Wm. Doyle,	Albany,	N. Y.	15
Pipe,—Making Sheet Metal	C. T. Boardman,	Bergen Point,	N. J.	8
—— Wrench,	Wm. F. Beecher,	Chicago,	Ill.	1
Ploughs,	J. H. Gooch,	Oxford,	N. C.	8
——	J. S. Willson,	Waynesboro',	Ga.	8
——	Wm. C. Pitts,	Austin,	Texas,	15
——	Wood & Byrington,	Byron,	Ill.	15
——	J. S. Huggins,	Timmonsville,	S. C.	22
——	I. N. Rankin,	Middletown,	Iowa,	22

Ploughs, .	Rhodes & Skaggs, .	Talladega,	Ala.	22
——— .	C. I. Shiver, .	Camden,	S. C.	22
———,—Clevis for	Calvin Adams, .	Pittsburgh,	Penna.	22
———,—Cultivating .	Allen Hughes, .	Gratiot,	Ohio,	29
———,—Mold-boards for	H. H. Scoville, .	Syracuse,	N. Y.	29
———,—Spade .	Elijah Harris, .	Princeton,	Ill.	22
Plough Stocks, .	J. A. Boyd, .	Jackson Co.,	Fla.	1
Pointers,—Perforating Rule for	Wm. H. Harding,	Philadelphia,	Penna.	1
Post Butt, .	James Holland, .	Conshohocken,	"	15
Potato Diggers, .	John Bawden, .	Freehold,	N. J.	8
——— .	Elijah Robertson, .	Hartford,	Conn.	8
——— .	David Niven, .	Rochester,	N. Y.	15
——— .	Carolus Dunham, .	Batavia,	"	22
Powder Flasks, .	G. W. Whipple,	West Acton,	Mass.	1
Preserve Cans, .	Theodore Sellers, .	E. Birmingham,	Penna.	22
——— .	Wm. H. Harn, .	Carlisle,	"	22
——— .	A. T. Twing and others,	Lansingburgh,	N. Y.	22
Printers Composing Stick,	S. W. Brown, .	Syracuse,	"	22
Printers,—Roller Boxes for	H. J. Spiller, .	Cincinnati,	Ohio,	29
Printers Rule,—Tool for Miter'g	Grover & Pelouse,	Middletown,	N. Y.	29
Printing Addresses on Papers,	Noah Bowles, .	"	Md.	1
Prisons,—Window Grating for	Edwin May, .	Indianapolis,	Ind.	29
Presses,—Power .	Charles Oyston, .	Little Falls,	N. Y.	22
——— .	James Weed, .	Muscatine,	Iowa,	22
Propellers,—Applying Steam to	A. M. Sawyer, .	Athol,	Mass.	8
Prunes,—Curing .	Isaac Reckhow, .	Brooklyn,	N. Y.	22
Pumps, .	George Lindsay, .	Petersburgh,	Va.	1
——— .	J. E. Atwood, .	Bucksport,	Maine,	8
——— .	Walter Peck, .	Rockford,	Ill.	8
——— .	Washburn Race,	Seneca Falls,	N. Y.	22
——— .	J. M. Stephenson, .	Anderson,	Ind.	22
——— .	G. H. Mills, .	East Boston,	Mass.	22
Quartz,—Machinery for Crush'g	J. C. Dickey, .	Saratoga Sp'gs,	N. Y.	8
Raft,—Life-saving .	S. B. Broad, .	City of	N. Y.	8
Railroads,—Rails for Street	George Eaton, .	Boston,	Mass.	1
Railroad Cars,—City .	W. C. Allison, .	Philadelphia,	Penna.	29
———,—Journals for	Humphrey Jackman,	Elizabethport,	N. J.	1
———,—Propelling	Busser & Harmer, .	Philadelphia,	Penna.	8
———,—Ventilator for	Asa Hapgood, .	Worcester,	Mass.	22
——— Chairs, .	I. W. Wetmore, .	Erie,	Penna.	15
——— Jacks, .	F. H. Furniss, .	Cleveland,	Ohio,	15
Ranges,—Cooking .	F. S. Merritt, .	City of	N. Y.	1
———, &c.,—Water-backs for	W. S. Mayo, .	"	"	1
Ratan Machine, .	Liveras Hull, .	Charlestown,	Mass.	29
Reels,—Silk or Thread	S. W. and J. F. Palmer,	Auburn,	N. Y.	15
Rice Hullers, .	I. M. Hendricks, .	Philadelphia,	Penna.	29
—— and Clover Hullers,	Stephen Burrows,	Whitewater,	Wis.	8
Rifle Canes, .	Andrew Crow, .	Middlefield,	Mass.	8
Rocking Chair, .	H. J. Coster, .	Chicago,	Ill.	8
——— into a Cradle,	R. H. Ewing, .	Nicollet Co.,	Minn.	8
Rotary Engines, .	A. F. Reeder, .	Bloomington,	Ill.	15
Ruffles,—Manufacture of	G. B. Arnold, .	City of	N. Y.	8
Saccharine Juices,—Evaporat'g	L. P. Harris, .	Mansfield,	Ohio,	29
———	A. C. Clemens, .	Crain township,	"	22
Salt,—Manufacture of Common	Thomas Spencer,	Syracuse,	N. Y.	29
Sash-fastener, .	J. M. Whitney, .	Astoria,	"	15
——— .	Ross Johnson, .	Baltimore,	Md.	29
Sausage Filler, .	Amos Shepard, .	Southington,	Conn.	22
——— Machine,	J. G. Perry, .	S. Kingston,	R. I.	15
Saw-set, .	A. L. Currier, .	Washington,	D. C.	15
Saw Teeth,—Machine for Cut'g	Frederick Shuttee,	Philadelphia,	Penna.	29

Saws,—Machine for Filing	Patrick McMahon,	Scottsville,	N. Y.	1
—,—Hanging Reciprocating	Charles Weston,	Salem,	Mass.	8
Screw Plates,	Z. L. Jacobs,	Hebron,	Conn.	15
Seeding Machines,	W. J. Baker,	Dimock,	Penna.	8
———	A. E. Doty,	N. Henderson,	Ill.	22
———	David Eldred,	Monmouth,	"	22
———	A. Kirlin,	New Boston,	"	22
———	S. T. Holly,	Rockford,	"	29
———	J. R. Turner,	Jacksonville,	"	8
Seed Planters,	W. C. Pitts,	Austin,	Texas,	15
———	Ephraim Russell,	Coatsville,	Penna.	15
———	J. W. Masten,	Utica,	Mich.	22
Sewing Machines,	J. S. McCurdy,	Brooklyn,	N. Y.	1
———	G. B. Arnold,	City of	"	8
———	Birdsill Holly,	Lockport,	"	8
———	E. E. Bean,	Boston,	Mass.	8
———	George Little,	City of	N. Y.	15
———	Samuel Hoffman,	Richmond,	Va.	22
———	J. N. Chamberlin,	Troy,	N. Y.	29
———	Hamilton Ruddick,	Boston,	Mass.	29
Shaving Cup,	T. E. Hughes,	Birmingham,	Penna.	1
Shears,—Rotary Cutting	C. W. Brown,	Boston,	Mass.	22
Sheathing Felt,—Manufacturing	J. B. Hyde,	Newark,	N. J.	29
Shingle Machines,—Feed'g Bolt	N. S. Gilbert,	Albion,	N. Y.	8
Shoe Plate,	T. W. Porter,	Bangor,	Maine,	8
Shoemakers Float,	F. L. Langley,	Troy,	N. Y.	15
Shot and Shells,—Moulding	David Huestis,	Cold Spring,	"	15
Shovels,—Manufacture of	S. D. Nelson,	Pittsburgh,	Penna.	15
Shovel and Tongs,—Combinat.	J. W. Evans,	Forsyth,	Ga.	15
Shutters,—Metallic Rolling	J. B. and W. W. Cornell,	City of	N. Y.	15
Signal Apparatus,	T. T. Woodward,	S. Reading,	Mass.	15
Silicates,—Preparation of	G. E. Vanderburgh,	Mamoraneck,	N. Y.	29
Skates,	John Lovatt,	Newark,	N. J.	29
———	Wm. Scarlett,	Aurora,	Ill.	29
———,—Wheel	Reuben Shaler,	Madison,	Conn.	29
Sliver Machines,	F. T. Grant,	Gardiner,	Maine,	29
Smut Machines,	G. B. Turner,	Cuyahoga,	Ohio,	1
Snow or Ice into Large Blocks,	Harris Morse,	Columbia,	Cal.	15
Soil,—Breaking and Pulverizing	R. J. Gatling,	Indianapolis,	Ind.	29
Spinning Yarn,—Machinery for	J. E. Crowell,	Chelsea,	Mass.	8
———	Edmund Victory,	Watertown,	"	8
Spirit Levels,	W. T. Nicholson,	Providence,	R. I.	1
Spring Balances,—Compensat'g	O. S. Squyer,	West Dresden,	N. Y.	8
Starch,—Machinery for Clean'g	C. S. Irwin,	Madison,	Ind.	15
Steam Boiler Feeders,	Sanderson & Stanton,	Syracuse,	N. Y.	15
——— Furnaces,	D. H. Williams,	Alleghany,	Penna.	15
——— Regulator,	C. A. Wilson,	Cincinnati,	Ohio,	1
——— Boilers,—Alarm Valves	Selah Dustin,	Detroit,	Mich.	8
———,—Safety Valve,	W. Mt. Storm,	City of	N. Y.	1
———,—Sediment Col.	J. T. Price,	Rockville,	Ind.	15
———,—Therm. Cases	G. E. Hayes,	Buffalo,	N. Y.	8
——— Engines,	John Randall,	Elmira,	"	8
———,—Air Pumps	D. A. Woodbury,	Rochester,	"	8
———,—Slide Valves	Andrew Buchanan,	Jersey City,	N. J.	15
———,—Governors	G. W. Raine,	Newburgh,	N. Y.	29
———,—Gov. Valves	Wm. Chambers,	Muscatine,	Iowa,	1
——— Traction Engines,	J. F. Holloway,	Saline Mines,	Ill.	29
——— Gauges,	E. G. Allen,	Boston,	Mass.	1
——— Generators,—Coal Oil in	Thomas Shaw,	Philadelphia,	Penna.	29
Stills,—Construct. Condensers of	Patrick Mihan,	Boston,	Mass.	15
Straw Cutters,	N. Edwards & E. G. Day,	Chittenden Co.,	Vt.	1
Stoves,	Samuel Shadbolt,	Scottsville,	N. Y.	8
———	J. C. Henderson,	Albany,	"	29

Stoves,	J. G. Treadwell,	Albany,	N. Y.	15
———,—Cooking	J. C. Henderson,	"	"	1
Stove Grates,	Edward Mingay,	Boston,	Mass.	1
Sugar,—Machine for Drying	A. W. J. Mason,	New Orleans,	La.	8
———,—Appa's for Cut'g Loaf	Kinzler & Rosebrock,	City of	N. Y.	8
——— Juices,—Evaporating	Charles Harvey,	Richmond,	Ind.	8
Swift,	C. P. S. Wardwell,	Lake Village,	N. H.	15
Syringes,—Enema	F. B. & B. L. Richardson,	Boston,	Mass.	8
Table Fork,	Wm. Mannheimer,	City of	N. Y.	1
Telegraphic Machines,	Jedediah Weiss,	Bethlehem,	Penna.	15
——— Instruments,	A. G. Holcomb,	City of	N. Y.	15
Threshing Machines,	D. S. Wagner,	Penn Yan,	"	1
Tire,—Cooling and Setting	Permin Kopfer,	Fond du Lac,	Wis.	29
——,—Shortening	Abraham Voorhees,	Grand Rapids,	Mich.	22
——,—Shrinking	S. S. Greene,	Rome,	N. Y.	29
Tobacco Presses,	T. N. Read,	Aspen Wall,	Va.	22
Toy Cannons,	J. O. Couch,	Middlefield,	Conn.	1
Troughs,—Making Rain,	Wm. H. Henderson,	Franklin,	Ind.	22
Trunk Lock,	S. Bourne, Jr.,	City of	N. Y.	1
Tube Joints,—Making	S. I. Hayes,	Chicago,	Ill.	29
Tweer,	Alanson Ordway,	Stratham,	N. H.	15
Type,—Machine for Setting	C. W. Felt,	Salem,	Mass.	29
Valve Cocks,	Nickerson & Colton,	Athens,	Ga.	8
Vapor Burners,	Wm. N. Brown,	Camden,	N. J.	15
Vegetable Slicer,	S. T. Sanford,	Fall River,	Mass.	22
Veneers,—Mosaic	Heinigke and Laemmel,	Bay Ridge,	N. Y.	29
Vise,	T. B. Lamb,	Summit,	Mich.	22
Voltaic Gas Batteries,	Maurice Vergnes,	City of	N. Y.	15
Wagon Shaft Shackle,	J. B. Thorp,	Plantsville,	Conn.	1
Walls,—Construc. of Concrete	S. T. Fowler,	Brooklyn,	N. Y.	1
Washing Machine,	Ingraham & Rounds,	Berlin,	Wis.	8
———	E. D. Thomas,	Rochester,	N. Y.	8
———	J. S. Pond,	Cleveland,	Ohio,	15
———	"	"	"	22
———	Mark Richardson,	Philadelphia,	Penna.	22
———	Clark Roberts,	Winchester,	Ill.	22
———	A. Leightheiser,	Reading,	Penna.	29
———	S. W. Woodward,	Buffalo,	N. Y.	29
Water Elevator,	Maximilian Wappich,	Sacramento,	Cal.	29
——— from Wells,—Elevating	Billings & Hutton,	Cleveland,	Ohio,	22
——— Heating Appa's—Valve	J. E. Boyle,	Brooklyn,	N. Y.	1
——— Wheels,	G. H. Jones & J. Brown,	Rose,	"	1
———	Lyman Gibson,	Elmira,	"	1
———	A. M. Swain,	Lowell,	Mass.	15
Window Sashes,—Hanging	Thomas Fry,	Brooklyn,	N. Y.	15
Windlasses,	S. D. Avery,	Norwich,	"	8
Wind-mills,	E. W. Mills,	Amber,	"	1
———	W. J. Tustin,	Benicia,	Cal.	22
Wood,—Machines for Bundling	W. L. Williams,	City of	N. Y.	8
——,—Preparing & Moulding	Philander Shaw,	Boston,	Mass.	15
Wool,—Removal of Burrs from	C. L. Harding,	Winooski Falls,	Vt.	29
Wrench,	G. B. Phillips,	Newark,	N. J.	15
Wrenches,—Rolling Shanks of	L. and A. G. Coes,	Worcester,	Mass.	8
Wringing Clothes,	J. H. Clark,	Westbrook,	Maine,	8
Writing Desk,	Elisha Hughes,	McCartysville,	Cal.	1
Yards to Topmasts,—Attachm't	Samuel Hall,	Boston,	Mass.	22
——,—Hanging Topsail	James Nute,	East Boston,	"	22

EXTENSIONS.

Sugar Pans,	Alfred Stillman,	City of	N. Y.	22
Wood Screws,—Manufacturing	T. W. Harvey,	"	"	29

ADDITIONAL IMPROVEMENTS.

Fire Arms,—Revolving	E. D. Newbury,	Albany,	N. Y.	1
Protractor,	Josiah Lyman,	Lenox,	Mass.	15
Tenons on Spokes,—Cutting	Mahlon Gregg,	Philadelphia,	Penna.	15
Washing Machine,	Charity Pendleton,	Galena,	Ill.	29

RE-ISSUES.

Bells,—Hanging	G. W. Hildreth,	Lockport,	N. Y.	1
Bonnet Frames,	W. E. Kidd,	City of	"	15
Burglars Alarms,	Wilson & Thomas,	Frankfort,	"	22
Corn Huskers,	D. M. Mefford,	Jeffersonville,	Ind.	15
Curtain Fixtures,	Lewis White,	Hartford,	Conn.	22
Gas,—Heating or Cooking by	W. F. Shaw,	Boston,	Mass.	29
Harvesters,	C. B. Brinckerhoff,	Batavia,	N. Y.	22
————,—Grain and Grass	C. Aultman & Co.,	Canton,	Ohio,	1
————————	"	"	"	1
Iron Pavement,—Cellular	Titus & Des Granges,	St. Louis,	Mo.	1
Kettles,—Grinding Cast Iron	C. C. Bradley, Jr.,	Syracuse,	N. Y.	1
Knitting Machines,	Tompkins & Johnson,	Troy,	"	15
Ranges,—Cooking	H. H. Stimpson,	Boston,	Mass.	1
Steam Boilers,—Prev. Incrust. of	H. F. & L. F. Knoderer,	Chillicothe,	Ohio,	15
Stoves,—Coal	C. Eddy & J. Shavor,	Troy,	N. Y.	8
Sugar,—Machine for Cut'g Loaf	A. & F. Brown,	City of	"	1
Sugar Mould Carriages,	C. E. Bertrand,	Williamsburgh,	"	29
Water-proof Leather Goods,	Samuel La Forge,	Cleveland,	Ohio,	15
Wheel Hubs,—Casting Boxes	Thomas Ellis and others,	Philadelphia,	Penna.	1

DESIGNS.

Spoon and Fork Handles,	M. Gibney,	City of	N. Y.	15
Stove,	J. Greer & R. I. King,	Dayton,	Ohio,	15
—— Plates,	Hubbell & Wood,	Buffalo,	N. Y.	15
Stoves,	Jacob Resor,	Cincinnati,	Ohio,	15
Stove Plate,	J. Siddons & J. C. Hart,	Rochester,	N. Y.	15
Stoves,—Parlor	Wm. W. Stevens,	Portland,	Maine,	15

FRANKLIN INSTITUTE.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination—"A method of Lighting Gas by the Electric Spark invented by Mr. Arch. Wilson, of the City of New York,"

REPORT:—That the apparatus proposed by Mr. Wilson for this purpose, consists, first, in an insulator applied to every burner which is to be lighted, so as to cut off all electric communication between the burner and the gas-pipe; secondly, in the establishment of proper electric conductors between the burners thus insulated; and thirdly, in bringing the ends of the conducting wire into communication with the poles of one of Ritchie's Induction Apparatus, by means of which a spark may be caused to pass at each break in the circuit.

First; the insulator consists at present of a piece of hard india-rubber screwed on to the top of the gas-pipe, into the upper end of which the burner in its turn is screwed. Over this insulator is slipped a loop of copper wire, one end of which is turned upwards and bent so as to present its end immediately over the opening of the burner; the loop

is also connected with a copper wire which passes to the next preceding burner. It will be seen that when this arrangement is completed, if an electric current be passed over the wire sufficiently powerful to overcome the resistances at the breaks, a spark will pass from the end of each wire, through the air above the opening, to the burner, and from the first burner will pass to the next, and so in succession generating a spark at each opening of the circuit. But to effect this, very considerable tension will be required in the current.

Secondly; the wires are arranged in such order, passing from the Ritchie to the wire above the first burner; then from this burner to the wire above the second, &c.; that (including the spark passage across the air from the wires to burners) there is a single electric communication made by bringing the first and last wires into communication with the poles of the Ritchie coil; and thus the conditions of the last paragraph are fulfilled, provided the coil be sufficiently powerful.

Thirdly; Ritchie's Induction Apparatus (or, as the maker calls it, Ritchie's Rhumkorff's Induction Apparatus) is an apparatus in which, by very ingenious arrangements which this is not the proper place to describe, a very long and powerful spark is obtained from the secondary or induction current from a battery which may be of few cups and of small dimensions. The apparatus with which Mr. Wilson experimented before the Institute, is capable of giving a spark of 11 inches in length in the air. And as the resistance to the passage of the spark seems to be in the inverse ratio of the square of the distance; this power ought to be able to pass across more than seven thousand openings of $\frac{1}{8}$-inch each.

After thus briefly explaining the mode of lighting proposed by Mr. Wilson, and referring those particularly interested to the more full explanations given by Mr. W. in his remarks before the Institute at the meeting in March (see *Jour. Frank. Inst.*, vol. xxxix, p. 385), let us inquire into its novelty and its probable utility. Any student of electric science or practice will have at once suggested to his mind two modes in which this force may be used to ignite a current of gas at a distance: the first, by means of the heating power of the current while passing through an insufficient metallic conductor; under which circumstances the conductor becomes red, or even white hot; the other by means of the spark, which is in effect a small portion of matter intensely heated for a single moment. Now in order to meet the exigencies of practice, the mode of lighting, as Mr. Wilson very properly remarks, must be "simple, easy to adjust, efficient, reliable, and economical." Let us inquire how far these properties are possessed by each of the suggested modes.

And first as to the efficiency. The mode of lighting, by heating portions of a continuous conductor, depends upon the creation of a resistance to the passage of the current, by which resistance the heat is developed. In proportion, then, as you increase the number of your resistances you must increase the power of your battery—and as each retardation diminishes the amount of the current; if it happen that the second, or any succeeding wire is more capable of passing the cur-

rent than the first, this wire will not heat. When, then, an attempt is made to ignite a number of gas-jets by fine platinum wires stretched above them, and communicating by means of a larger conductor, care must be taken that the first be not either finer or longer than any of the others, otherwise those which are coarser or shorter than the first will not produce their effect. Again, great care must be taken to insure an equality in the quantity of the current passed; for when the wires have been adjusted to a certain quantity, a less quantity will not heat them; a greater quantity will be liable to fuse them. Again, care must be taken that the wires are stretched immediately over the opening of the burners; a slight variation to the right or left will entirely prevent the lighting. When all these precautions are taken, a strong breeze of air, or even perhaps the current of gas issuing under a heavy pressure will cool the wires too rapidly to prevent the lighting. And it must be remembered that a low red heat is not sufficient to ignite a mixture of lighting-gas and air.

In reference to reliability; the wires are apt to fuse and thus break the connexion; to expand irregularly by the heat and thus be bent away from the opening of the burner; to incrust with soot, or dust, or damp, and thus prevent their ignition. They are simple but not easy to adjust or to keep in adjustment; and as to economy, require a much larger battery, and therefore more consumption of zinc and acid than the present plan.

But, in fact, from the operation of the causes we have pointed out under the heads of efficiency and reliability, this mode has always failed in practice, and we are obliged to have recourse to the spark, if we can succeed at all.

The great objection which has hitherto prevented the spark from being practically applicable to lighting gas, has been the difficulty of procuring and confining a current of sufficient intensity to overcome any great number of interruptions, and thus to produce the required number of sparks. The galvanic battery was not available, for the spark produced directly, is small and feeble; the electric machine is fragile, uncertain, difficult to keep in order, dependent on the weather, and laborious to work with. So that although propositions to light by spark are quite numerous both in England and France, yet in practice the method had never succeeded on trial, especially in a permanent manner.

Now the only practical method known to us of obtaining surely, efficiently, and easily, sparks sufficient for this purpose, is by the Induction coil, and we do not think we advance too far when we say by Ritchie's modification of this instrument; by which a spark of 11 or 15 inches can be produced, while heretofore they have never exceeded 3 inches.

The experiments made before the Committee and before the Institute by Mr. Wilson, as well as those which have been in operation for a year in New York on a practical scale, appear to demonstrate that this mode of lighting is efficient inasmuch as it is able to light many hundred burners at any distance within the limits of our largest rooms,

and probably even in our streets; that it is reliable, inasmuch as it is not liable to get out of order, or to deteriorate (provided the wires from which the sparks are taken are made of platina or some other refracting metal); that it is easy to adjust, requires no re-adjustment, unless by accident, when the damaged locality is easily detected and easily repaired; that it is simple, requiring no knowledge for its management, except for the filling the cells of the battery (which need not exceed three cups) with the acid, an operation probably not required more than once a month if the apparatus is used several times every night; and it is economical, both because of the small quantities of material consumed by the small battery required, and from the instantaneous action, saving a large quantity of gas which is now suffered to run to waste while the burners are lighted successively. The spark can also be repeated indefinitely and rapidly so as to light on a second or subsequent trial any burners which may have escaped the first attempt.

For these reasons, and on account of the experiments made in their presence, as well as of those tried elsewhere, the Committee report that in their opinion there is every reason to believe that Mr. Wilson's Electric Gas-lighter will be successful in practice; and that it is well worthy of trial on a large scale.

By order of the Committee,

WM. HAMILTON, *Actuary.*

Philadelphia, June 14th, 1860.

BIBLIOGRAPHICAL NOTICE.

Elements of Chemical Physics. By JOSIAH P. COOK, Jr., Erving Professor of Chemistry and Mineralogy in Harvard University. Boston: Little, Brown & Co., 1860, 8vo.

This work is intended especially to furnish to the student of chemistry a knowledge of such of the theories and facts in physics as are likely to be of importance to him in the pursuit of his investigations; and is designed to be the first volume of an extended work on the philosophy of chemistry. Of course, the work can hardly be fairly judged of until it is complete. The volume before us has the merit of being well brought up to the present state of knowledge upon the subject, but contains only the treatise on general properties of matter and that on heat, both of which are limited in accordance with the avowed purpose of the author. We fear, therefore, that if the work be completed on the same scale, it will be of unwieldy bulk, and scarcely so well adapted to the purposes of the chemist as the more terse work of Peschel, and others of his class. As a text-book of physics it can hardly be made available in any course of instruction fitted to the demands of the present day owing to the want of all mathematical treatment of the subjects. The definitions, too, are not so precise as they ought to be in Science, and an apparent haste of writing has sometimes led the author into errors of statement, which in a future edition should

be carefully corrected: thus, for instance, on page 57, he affirms the centre of gravity of the earth to be a *variable* point *near* the centre of the globe. The work, however, is one of good promise, admirably printed and illustrated, (though it would have been better to have changed the French legends of the wood-cuts,) and the appendix contains a very valuable set of tables; one of which is a table of logarithms, which, if we understand the preface aright, has been calculated by Capt. Chas. Henry Davis. F.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

JUNE.—The month commenced with indications of a coming storm. The barometric column began to fall on the 2d, and continued to fall until the afternoon of the 5th, when it reached the minimum for the month, reading at 2 P. M. of that day 29·243 inches. It then rose, slowly but regularly, until the 14th, when it again began to fall. This second wave reached its minimum on the 20th; after which it rose rapidly until the morning of the 25th, when it reached 30·123, the maximum for the month, and again gradually declined until the close. The newspapers soon brought the information of a very destructive tornado, commencing about Cedar Rapids in Iowa, on the evening of Sunday, the 3d of the month. It is described as dividing at Cedar Rapids into two winds, which passed very rapidly in curved lines to Camanche, where they united and crossed the river into Illinois, striking Albany and passing on to Amboy. The distance traversed was about 150 miles, which it accomplished in about two hours. Upwards of 200 lives were lost, and the destruction of property was very great.

On the evening of the same day a few drops of rain fell at Philadelphia; but on the next day, about 7 P. M., a heavy rain storm commenced, accompanied with thunder and lightning, and continued with but few intermissions until the morning of the 6th. During this period of two days and a half, about 2¾ inches of rain fell.

A heavy gale is also mentioned as having occurred in North Carolina on the morning of the 5th.

It is impossible with the limited information which we possess to determine whether or not these were all parts of the same storm.

On the morning of the 8th, a hail-storm continuing about fifteen minutes, passed over the northern part of the city; in the vicinity of Germantown and Manayunk a heavy rain fell at the same time, while in the southern part of the city there were but a few drops.

During the second depression of the barometer, from the 16th to the 19th of the month, we had several thunder-showers at Philadelphia; and we have accounts of a severe hail-storm and tornado in Lancaster County, Pa., on the 19th. Much damage was done to property by the wind, and the hail completely destroyed the crops along

its route. The average width of the storm did not exceed three-quarters of a mile.

The mean temperature of the month was about one degree higher than that of June of last year, but was nearly two degrees below the average of the month for the last nine years. The coldest day was the 21st, the average temperature being 60°. The thermometer was lowest on the morning of the 12th, when it indicated 52°. The thermometer was highest on the afternoon of the 29th, marking 93°; but the 30th was the warmest day of the month, its average temperature being 85·3.

Rain fell on ten days of the month, which is very near the average number for June. The amount of rain which fell during the month was 3·706 inches, which is an inch and a half less than that which fell in June of last year, but not more than half an inch below the average for June for nine years.

There was but one day of the month entirely clear, and two days on which the sky was completely covered with clouds at the hours of observation.

The force of vapor and relative humidity were both considerably below the average for the month, as may be seen by an inspection of the following table of comparisons.

A Comparison of some of the Meteorological Phenomena of June, 1860, with those of June, 1859, and of the same month for nine years, at Philadelphia.

	June, 1860.	June, 1859.	June, 9 years.
Thermometer.—Highest,	93°	96°	98°
" Lowest,	52	42	42
" Daily oscillation,	18·90	18·90	16·00
" Mean daily range,	4·20	6·10	4·60
" Means at 7 A. M.,	67·70	67·05	69·25
" " 2 P. M.,	78·08	76·76	79·29
" " 9 P. M.,	69·05	68·74	72·07
" " for the month,	71·71	70·85	73·54
Barometer.—Highest,	30·123 in.	30·152 in.	30·281 in.
" Lowest,	29·243	29·520	29·182
" Mean daily range,	·088	·116	·096
" Means at 7 A. M.,	29·757	29·881	29·825
" " 2 P. M.,	29·719	29·842	29·791
" " 9 P. M.,	29·745	29·859	29·803
" " for the month,	29·740	29·861	29·806
Force of Vapor—Means at 7 A. M.	·467 in.	·501 in.	·527 in.
" " " 2 P. M.	·464	·541	·550
" " " 9 P. M.	·480	·512	·563
Relative Humidity at 7 A. M.	68 per ct.	72 per ct.	73 per ct.
" " 2 P. M.	48	57	55
" " 9 P. M.	67	72	70
Rain, amount in inches,	3·706	5·229	4·360
Number of days on which rain fell,	10	12	11
Prevailing winds,	s.67°23′w·236	s.71°2′ w.·393	s.75°40′ w·256

Abstract of Meteorological Observations for May, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	Philadelphia.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. Kirkpatrick, Observer.										Chambersburg, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. Wm. Heyser, Jr., Obs.							Indiana, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. Hildebrand, Obs.			Freeport, Armstrong Co. 40° 44′ N. 79° 42′ W. Height 1000 feet. J. H. Baird, Obs.		
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.		Barom.	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Thermometer.			Thermometer.		
May.	Mean.	Mean daily range	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.				Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean daily range.	Prevail'g winds.	Mean.	Mean daily range.	Prevailing winds.
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.		Inch.	°	°	Inch.	Per ct	Inch.	Direc.	°	°	Direc.	°	°	Direc.
1	29·849	·076	47·7	6	6·8	·296	85	0·850	E N E.		29·346	49·0	3·7	·256	61	} 0·840	E.	45·7	21·0	(var.)	43·3	17·0	N W.
2	29·742	·107	53·0	12	5·3	·333	80	0·835	N E.		29·321	54·3	5·3	·296	52		E.	52·3	11·3	N.	53·0	9·7	(var.)
3	29·793	·052	55·3	11	3·7	·224	43	0·070	N N E.		29·346	60·7	6·3	·276	39		(var.)	62·3	10·0	N.	60·7	7·7	W.
4	29·773	·029	64·3	27	9·0	·325	39		N N W.		29·303	63·0	3·0	·345	42		(var.)	65·3	3·7	N W.	66·0	5·3	?
○ 5	29·796	·034	67·8	26	3·5	·328	34		(var.)		29·300	68·7	5·7	·382	37		E.	65·3	3·3	N W.	67·7	3·7	W.
6	29·791	·037	71·3	31	3·8	·433	38		S S W.		29·273	72·7	4·0	·411	36		E.	68·7	3·3	(var.)	70·7	4·3	S W.
7	29·728	·063	74·0	28	4·7	·548	40	0·475	(var.)		29·257	77·0	4·3	·850	68		(var.)	74·0	5·3	W.	74·7	4·0	S W.
8	29·859	·132	59·5	15	14·5	·445	77		N E.		29·320	73·0	4·7	·598	58		(var.)	73·7	1·0	(var.)	71·7	3·7	?
9	29·845	·034	62·5	19	3·7	·465	61	0·042	N E.		29·250	64·0	9·0	·465	79	1·365	(var.)	70.7	3·3	N E.			(var.)
10	29·901	·056	61·7	6	4·5	·463	78	0·040	E S E.		29·205	67·3	5·3	·559	71	1·315	E.	63·0	7·7	E.	55·3		(var.)
11	29·973	·072	63·8	11	2·2	·470	71		S E.		29·246	63·3	4·0	·502	79	0·575	E.	64·0	3·7	E.	62·3	7·0	E.
◐ 12	30·018	·070	61·7	8	2·2	·516	91	0·240	S E.		29·286	62·7	0·7	.502	79	0·410	E.	63·3	4·0	S E.	59·0	4·7	E.
13	29·892	·126	67·2	22	6·5	·480	51	0·047	(var.)		29·219	62·0	1·0	·433	72	0·140	E.	63·7	5·7	S S E.			?
14	29·721	·170	64·8	13	4·0	·507	74	0·046	(var.)		29·097	66·3	4·0	·510	63		E.	63·7	3·3	S E.	65·0		N E.
15	29·864	·143	59·2	14	5·7	·282	44		(var.)		29·249	64·3	2·0	·350	46		N W.	68·7	5·0	E.	67·3	4·3	E.
16	29·837	·029	64·7	16	5·5	·270	28		S W.		29·214	67·3	3·0	·462	55		W.	67·7	1·0	N E.	63·7	3·7	N E.
17	29·992	·156	60·7	14	4·7	·376	55		E.		29·329	59·7	7·7	·256	62	0·085	(var.)	68·7	2·3	E.	67·0	4·3	N E.
18	29·847	·145	65·5	19	4·8	·517	63	0·044	(var.)		29·137	58·7	1·0	·491	88	0·417	E.	63·3	6·0	(var.)	62·3	5·7	S W.
19	29·522	·325	67·7	13	3·8	·332	40	0·017	S W.		28·824	62·7	4·0	·407	64	0·137	E.	59·0	5·7	(var.)	56·7	9·7	W.
● 20	29·679	·157	66·2	18	1·5	·353	45		W.		29·004	63·7	2·3	·206	28		(var.)	59·3	3·7	N W.	57·0	2·3	(var.)
21	29·770	·100	58·3	17	7·8	·353	50		N E.		29·041	60·3	3·3	·438	68	0·470	(var.)	70·7	11·3	S W.	69·0	12·3	W.
22	29·764	·050	63·2	24	6·8	·520	66	0·155	W.		29·120	66·0	6·3	·532	63		N W.	66·7	4·7	(var.)	66·3	3·7	(var.)
23	29·873	·109	68·2	20	6·7	·383	45		N N E.		29·246	68·7	3·3	·442	55		(var.)	68·3	3·7	N W.	65·3	4·3	(var.)
24	29·933	·060	69.0	12	2·2	·369	38		W N W		29·245	68·3	2·3	·402	45		E.	72·7	5·0	E.	69·7	9·0	(var.)
25	29·871	·062	74·3	24	5·3	·566	52		S W.		29·206	70·7	6·7	·572	52		E.	75·0	2·3	S E.	74·0	4·3	?
26	29·691	·180	72·7	16	1·7	·594	58	0·063	S W.		29·045	68·0	7·0	·612	89	0·353	E.	72·0	3·0	W.	72·3	2·3	S W.
☽ 27	29·687	·073	59·8	16	9·8	·427	77	0·100	(var.)		29·008	68·3	5·0	·505	56	0·108	E.	64·0	11·3	S W.	58·7	13·7	?
28	29·718	·035	59·7	14	3·2	·534	84	0·005	N N E.		29·047	68·3	1·0	·420	68		W.	65·7	4·0	N W.	62·7	4·0	W.
29	29·887	·169	66·3	23	6·7	·344	40		N E.		29·215	70·7	2·7	·407	43		S E.	70·3	4·7	(var.)	69·0	6·3	(var.)
30	29·829	·085	64·3	18	4·0	·432	57	0·182	S E.		29·152	68·0	2·3	·608	80	0·128	S E.	71·0	4·0	S E.	71·7	6·0	(var.)
31	29·666	·163	72·3	20	8·0	·580	55	0·378	S.		29·021	70·0	3·0	·449	52		S E.	67.7	4·7	W.	64·7	7·0	W
Means	29·810	·100	64·1	17	5·2	·421	57	3·589	N 59° E.		29·189	65·4	4·0	·459	60	0·343	S 87° E.	66·0	5·7	N 6° W.	64·4	6·3	N 60° W.